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Directorate of Combat Operations Analysis
US Army Combined Arms Combat Developments Activity
Fort Leavenworth, Kansas 66027

AN EVALUATION OF THE SURVEILLANCE, TARGET ACQUISITION, AND NIGHT OBSERVATION CAPABILITIES OF THE 101ST AIRBORNE DIVISION (AIRMOBILE)

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FOREWORD

The Scenario Recurring Evaluation System (SCORES) is a process developed by the US Army Training and Doctrine Command (TRADOC) for force design evaluations. SCORES was initially tasked by Department of the Army to evaluate several corps structures for Mideast operations. The resultant study is known as the Heavy/Light Corps Mideast (HLC-ME) Study.

The Combat Operations Analysis Directorate (COAD) of TRADOC's Combined Arms Combat Developments Activity (CACDA) provides scientific, technical, and methodological support to the SCORES process. This report documents COAD support to SCORES in satisfying the HLC-ME study objective to evaluate the surveillance, target acquisition, and night observation (STANO) capabilities of the 101st Airborne Division (Airmobile).

The authors acknowledge the help given by members of SCORES who aided in the military tactical aspects of this evaluation. Special thanks is given to Mr. Howard Haeker of COAD whose aid in the actual scenario reconstruction and data reduction proved invaluable.

ABSTRACT

The Scenario Recurring Evaluation System (SCORES) was directed by Department of the Army to evaluate several corps structures for Mideast operations. One objective of the resultant study, the Heavy/Light Corps Mideast (HLC-ME) Study, was to evaluate the surveillance, target acquisition, and night observation (STANO) capabilities of the 101st Airborne Division (Airmobile). This report documents support provided to SCORES by the Combat Operations Analysis Directorate (COAD) of the Combined Arms Combat Developments Activity (CACDA) in satisfying this objective.

COAD applied the model, Surveillance, Target Acquisition Routines for Manual War Games-Computerized (STARMAN-C) to selected portions of the SCORES Jiffy war game HLC-ME results, using the HLC-ME dynamic scenario. Model outputs were collected into measures of effectiveness (MOE), which provided quantitative values for an operational evaluation of the division's current capabilities and also for establishment of a baseline capability against which future augmentations to the division's STANO equipments may be compared.

Evaluation of the MOEs led to the identification of strengths in the division's current STANO configuration, such as superior SLAR capability and tank detection capability, and weaknesses, such as the limited capability to detect firing artillery tubes. The report includes insights and recommendations for exploiting the strengths and eliminating the weaknesses in the STANO capabilities of the division.

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AN EVALUATION OF THE SURVEILLANCE, TARGET ACQUISITION, AND NIGHT OBSERVATION CAPABILITIES OF THE 101st AIRBORNE DIVISION (AIRMOBILE)

1. PURPOSE. The purpose of this report is to aid the CACDA Scenario Oriented Recurring Evaluation System (SCORES) study team in satisfying one of the objectives of the Heavy/Light Corps Mideast (HLC-ME) Study (reference 1). The objective addressed herein is HLC Study objective 2a:

> Conduct a baseline assessment of the 101st Airborne Division (Airmobile), under H-series TOE, with emphasis on the division employed in a surveillance mission over extended frontages.

The analytical results of this report were developed to identify strengths and weaknesses of the surveillance, target acquisition, and night observation (STANO) capabilities of the 101st Division that warrant further investigation and to collect these strengths and weaknesses as comparative baseline values against which future augmentations of the 101st Division STANO equipment may be analyzed.

2. BACKGROUND.

a. Scenario Oriented Recurring Evaluation System (SCORES).

(1) SCORES is a force design and evaluation methodology generated within TRADOC to support the combat developments community. The process was conceived during the latter part of FY 73 and was originally known as the Living Model Process (reference 2). After several months of evolution, the process became known as SCORES. Basically, SCORES is an iterative process whose methodology involves several steps. Given a force troop list and deployment schedule, the first step is to incorporate that force into one of the TRADOC standard scenarios (reference 3). Next, several

situations or sequences, determined by the various force missions and employment schemes to be analyzed for a particular study, are developed within the context of the standard scenario in order to expose the relevant aspects of the force to investigation. Each study sequence is gamed at a coarse resolution level (phase 1) by the Combined Arms Center (CAC) with assistance from the functional centers and schools of TRADOC using the CAC manual, force-level (Jiffy) war game. The operational characteristics of the force are evaluated using this effort at the force level. The key issues exposed by the SCORES process requiring a resolution higher than force level are reviewed by a TRADOC Senior Officer's workshop and assigned to the appropriate functional centers or schools for fine grained analyses and evaluation (phase 2). Any recommended additions or deletions to the troop list, changes to the deployment schedule, or recommended force improvements resulting from major deficiencies identified in the evaluations are recycled through the SCORES process. This process is iterated until the capabilities and deficiencies of the force under consideration have been satisfactorily evaluated and recommendations developed to eliminate or minimize force deficiencies and to enhance force capabilities.

(2) Initial application of the SCORES methodology has been in conduct of the HLC-ME Study. The HLC-ME Study is a Department of the Army directed study (reference 4) to evaluate the capabilities and identify the deficiencies of both a heavy and a light corps in a Mideast environment. The HLC ME-I Study report, in which the results reported herein will appear, and the HLC-ME II study reports are to be published and provided to DA on 30 June 1974.

b. Combat Operations Analysis Directorate (COAD) Participation.

(1) As a part of CAC, COAD is responsible for providing technical support to the SCORES task force. COAD has provided technical support to several aspects of the SCORES process for the HLC-ME Study. This support has included development of an analysis methodology for SCORES applications, development of computerized routines and models to aid in the evaluation process, and the actual application of these models and others in the SCORES analysis efforts.

(2) One of the main responsibilities of COAD in support of SCORES has been to scrutinize constantly the SCORES methodology, and any changes thereto, for analytical and logical soundness and to develop improvements to enhance the SCORES process. Any newly developed process contains areas that warrant improvement. Some of the improvements to the SCORES process being actively pursued by COAD are a SCORES data storage, exchange, and retrieval system (reference 5); computerized routines to improve the CAC Jiffy war game in such areas as target acquisition and casualty assessment; and plans for the future application of force-level war games, other than Jiffy, which will be responsive to the parametric excursions and sensitivity analyses necessary during SCORES evaluations.

(3) COAD recently completed development of a computerized model that simulates surveillance, target acquisition, and night observation (STANO) devices. This model is called Surveillance, Target Acquisition Routines for Manual War Games - Computerized (STARMAN-C). STARMAN-C is a one-sided, deterministic model that operates on a predefined target array. A detailed description of the model is contained in appendix A. COAD intends to begin applying the model to a number of studies to

establish its credibility. COAD also intends to refine the model continually by maintaining an up-to-date data base and further simplifying the inputs to allow the model to run interactively, approaching real-time turnarounds. After these refinements have been made, and the model's credibility has been fully established, COAD expects to incorporate STARMAN-C into the Jiffy war game methodology.

3. METHODOLOGY.

a. Overview.

(1) The methodology developed by COAD for the 101st Division STANO capability evaluation consisted basically of application of the STARMAN-C model to selected portions of the HLC ME-I dynamic scenario. The STANO capabilities of the 101st Division were quantified by using the outputs from STARMAN-C as input to measures of effectiveness (MOE). These MOE are defined and evaluated in paragraph 4.

(2) A schematic logic diagram for the methodology is depicted in figure 1.

(a) The first step in the methodology was to define the portions of the sequences in ME-I that were to be examined (paragraph 3b below). Since the STARMAN-C evaluations occurred after the SCORES Jiffy gamers had concluded the development of the sequences in the dynamic scenario, the deployment and movement of the Red and Blue forces had to be manually reconstructed, or replayed. This procedure is portrayed in blocks 2, 3, and 6 of the methodology schematic. The primary source of data for this reconstruction was the sequence gaming reports. A detailed explanation of the regaming is provided in paragraph 3d below.

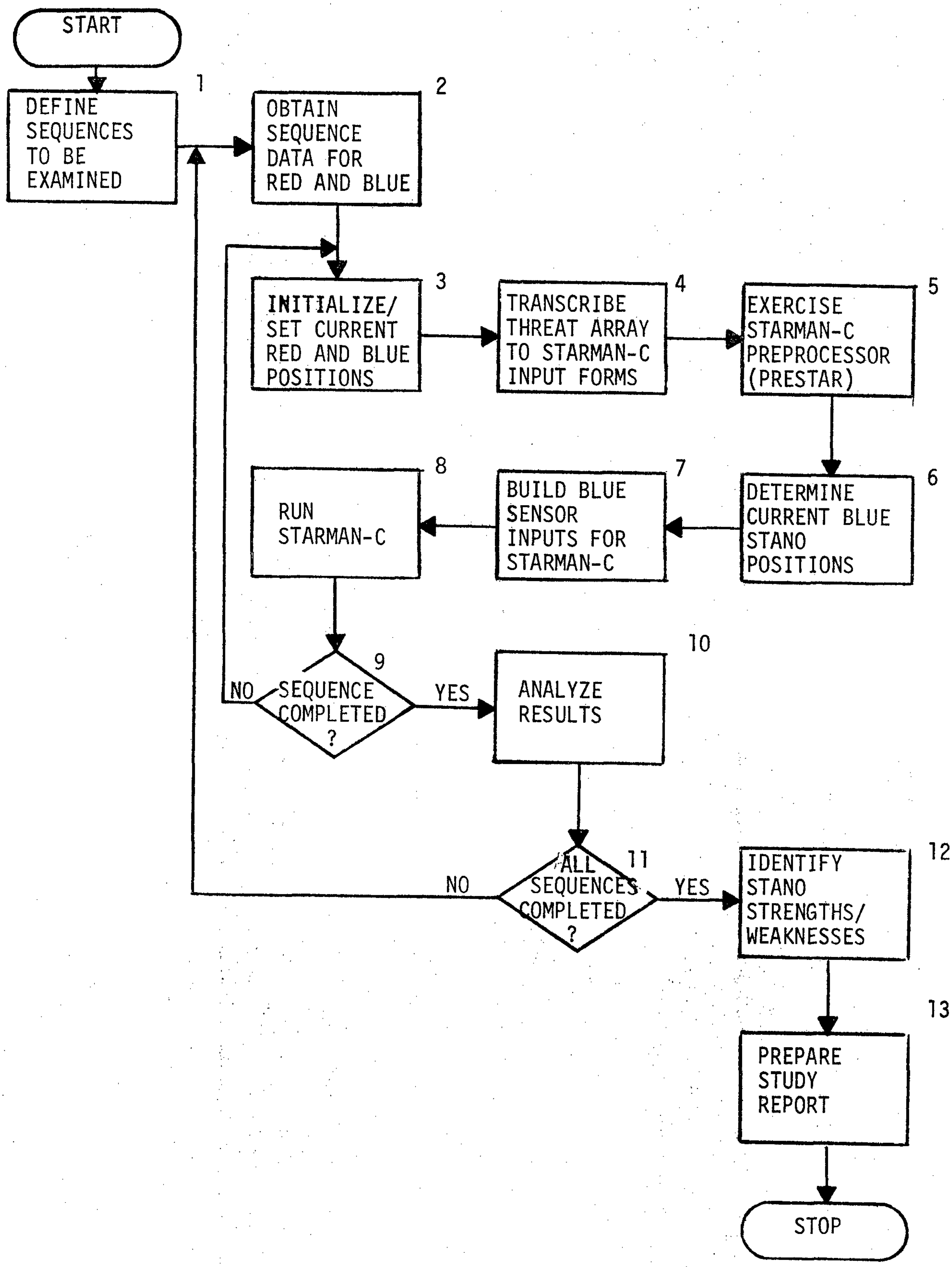

Figure 1. Evaluation methodology schematic

(b) The methodology shows that during the reconstruction the Red target threat array was transcribed to STARMAN-C target input forms for every time period (block 4). A sample of these forms is provided at appendix B. A target data input deck was punched from these forms, which were inputs for the STARMAN-C target preprocessor (PRESTAR). The preprocessor was exercised (block 5) to build a target data file for the STARMAN-C run.

(c) After the Blue sensor inputs were built (block 7), all the inputs were ready for the STARMAN-C run (block 8). Each run provided the detections of the STANO resources of the Blue forces for the given time period. The process (blocks 3 through 8)was iterated for each subsequent time period until the desired portion of the sequence had been reconstructed; the corresponding STARMAN-C runs were also completed (block 9). The results of each time iteration were collected and analyzed through the MOE, and the reconstruction of the next sequence was begun (blocks 10 and 11).

(d) After all sequences were completed and their results analyzed, the STANO strengths and weaknesses of the Blue force were identified. Finally, the conclusions and recommendations were prepared for a study report.

b. Scope of Effort. The surveillance capabilities of the 101st Division were evaluated in selected portions of sequences 2 and 3 in the SCORES ME-I dynamic scenario, sequences that exercised the maximum capabilities of the 101st Division STANO systems. The portion of sequence 2 selected was a 3-hour twilight-daylight portion starting at 0200 on scenario day D+17 (twilight) and continuing until 0500 (daylight).

During this time the 101st Division was in a screening situation. Two portions of sequence 3 were selected. The first was one nighttime hour of D+27 starting at 2400 and ending at 0100. The mission of the 101st Division during this period was to survey areas of active patrolling. The second portion was another twilight-daylight period, 2 hours long, starting at 0400 on D+27 and continuing until 0600. The Blue mission during this time period was to determine the point of penetration of a Red frontal assault.

c. Definitions. The following definitions will be helpful in understanding the discussion to follow. Standard US Army definitions are used except for those terms especially adapted for application to this analysis.

(1) Surveillance: Continuous, all weather, day and night systematic observation of the battle area to provide timely information for tactical ground combat decisions.

(2) Acquisition: The detection, identification, and location of a target in sufficient detail to permit the effective employment of weapons.

(3) Detection: An indication of the presence of a target of potential military interest.

(4) Target: Company-sized enemy unit for sequence 2 and sequence 3(day) analyses, and platoon-sized enemy unit for sequence 3(night) analysis. In choosing the target size, it was desirable to choose the largest group that moved together as one maneuver unit. Sequence 2 and sequence 3 (day) scenarios portrayed advancing/attacking enemy units, which moved in company or larger groups. In the sequence 3(night) scenario, the enemy units were in a reconnaissance mode in which their forces moved in platoons.

(5) Target Element: One piece of enemy combat equipment (e.g., tank, truck, BMP) or one individual enemy soldier.

(6) Presented Target: A target that passes within range of friendly surveillance or target acquisition devices.

(7) Circular Probable Error (CPE): The radius of a circle drawn around the true target center, which contains half of the reported (estimated) locations of the target center. Decreasing CPEs indicate an increasing target location accuracy.

(8) Surveillance Line (SL): An arbitrary line in front of which is the area to be surveyed.

(9) Surveillance Range Band: Area extending in width across the full SL frontage in a predetermined depth increment. For example, if the FEBA extends for 20 kilometers, and a total 40-kilometer depth forward of the FEBA is of interest; the depth dimension might be segmented into 2-kilometer increments. The third surveillance range band then would have a 20-kilometer front and in depth would extend from 4 to 6 kilometers forward of the SL.

(10) Acronyms:

SLAR - Side Looking Airborne Radar

AOP - Airborne Observation Post (helicopters)

GOP - Ground Observation Post (OP on or behind SL)

LRRP - Long Range Reconnaissance Patrol (OP in front of SL)

BNRDR - Battalion Radar (PPS-5)

d. ME-I Sequences 2 and 3 Reconstruction.

(1) The sequence reconstruction consisted of gathering the force deployment and movement data from the SCORES HLC-ME Study sources available.

These sources were composed of the sequence gaming reports (references 6 and 7), interviews with the Red and Blue teams, and Red and Blue team notes made during the actual playing of the Jiffy game. This information was used to reconstruct map overlays of the Red and Blue forces at 15-minute intervals during the portion of the sequence being investigated. Each overlay served as a snapshot, or a picture, of the forces at an instant of time. The level of resolution of the reconstruction was dependent on the data available for each sequence. Generally, data were available on the Blue forces down to company level; Red force resolution was down to brigade level in sequence 3 and battalion level in sequence 2.

(2) The structure of a SCORES dynamic scenario determines the nature of the gamed sequences. The dynamic scenario is the recorded results of the CAC force-level war game, which currently is the CAC Jiffy game. The scenario is partitioned into major divisions, called sequences. Each sequence is divided into parts, called critical incidents (CI); and each CI is further divided into actions. The various divisions of the scenario are event oriented; thus, there is no predetermined time duration for each part. An event of importance must occur to conclude an action, CI, or sequence and begin another.

(3) The techniques used in the sequence reconstruction were similar for the three portions of the two sequences investigated. The techniques used for sequence 2 are discussed in detail in the following subparagraphs. The techniques used for the two selected portions of sequence 3 are then discussed only in terms of differences from sequence 2.

(4) The portion of sequence 2 reconstructed for the evaluation was 3 hours in duration and restricted to the sector of the northern Red

division. A 1-to-50,000 map of the area was used for the reconstruction.

(a) The first step was to initialize the situation with the Red and Blue force deployments. These positions were recorded for each Red battalion and each Blue STANO device, including ground observation posts (GOP), on overlay 1. These positions are the first positions noted in the sequence 2 gaming report and are the positions of each force at the beginning of CI 1 of sequence 2.

(b) Next, the positions of each force were recorded on overlay 2 at the beginning of CI 2 of sequence 2. These positions were assumed to be the ending positions of CI 1. CI 1 lasted longer than 3 hours, the amount of time being investigated; thus, these positions and times served as the limits for the reconstruction of the force movements. If it could be assumed that each unit moved at a constant speed along a path from its starting point to its ending point, simple interpolation could be used to determine the unit's position at each 15-minute increment of time from the beginning of the initial reconstruction time; however, examination of the sequence 2 gaming report showed that the speeds of most Red units were nonuniform and the Blue units were relatively stationary. Thus, a factor was developed to compensate for this nonuniformity. This factor was derived in the following manner.

1. The gaming report included the speed at which a Red unit was capable of moving for each CI subdivision, or action. (The 3 hours of interest occurred during the first two actions of CI 1 in sequence 2.) Using the gaming report speeds for each action of CI 1, the total distance a Red unit was capable of moving during CI 1 was calculated. This

value was known as the "speed distance" and was calculated for each Red unit.

2. Next, the distance between the starting and ending positions on overlays 1 and 2 was measured for each unit. This value was known as "positioning distance." The nonuniform speed compensation factor was a ratio of the speed distance to the positioning distance. These values are shown in table I for all Red units played in the sequence 2 reconstruction.

3. The positions of each Red unit were then determined for each 15-minute snapshot of the sequence by time interpolation of the starting and ending positions, taking into consideration the speed nonuniformity by multiplying the interpolated value by the compensation factor. These positions were then recorded on STARMAN-C target input forms.

(5) The reconstruction of the Blue forces consisted generally of the development of a deployment/extraction schedule (table II) for its STANO devices, primarily because the STANO devices, except the devices on air platforms (SLAR and AOP) were relatively stationary. Basically, the ground devices were initially deployed, extracted at some given point in time during which they were considered inoperable for detection, and redeployed at some later time. The air platforms were handled in the same way except that the portion of the area being surveyed that was covered in a given time period was also considered. These values are contained in tables III through V. The Blue STANO inputs for STARMAN-C were built from these tables.

(6) The techniques used to reconstruct sequence 3 (night) differed in three respects from those used during sequence 2. The first

Table I. Sequence 2 nonuniform speed factors

Red Unit ID	Speed distance (kilometers)	Position distance (kilometers)	Factor
1	17.9	39.0	0.4590
2	29.3	39.0	0.7513
3	26.8	39.0	0.6871
4	20.4	39.0	0.5231
5	26.8	39.0	0.6871
6	25.8	33.3	0.7748
7	19.3	33.3	0.5796
8	19.9	34.4	0.5785
9	14.3	39.0	0.3667
10	30.6	39.0	0.7846
11	25.3	39.0	0.6487
12	25.3	39.0	0.6487
13	23.5	39.0	0.6026
14	23.4	39.0	0.6000
15	24.2	39.0	0.6205
16	21.8	39.0	0.5590
17	22.9	39.0	0.5872
18	23.3	39.0	0.5974
19	33.3	33.3	1.0000

Table II. Blue STANO deployment/extraction schedule

Sequence	STANO device	Deployment		Extraction	
		Time	Number	Time	Number
2	BNRDR	0200	3	-	-
	AOP	0245	2	0500	2
	LRRP	0200	2	0245	1
				0500	1
3 (night)	BNRDR	0015	5	-	-
	LRRP	0015	8	-	-
	SLAR	0015	1	-	-
3 (day)	BNRDR	0400	5	0415	4
				0445	1
		0500	6	-	-
		0530	1	-	-
	AOP	0400	2	-	-
	LRRP	0400	8	0415	5
				0445	3
	GOP	0500	7	-	-
		0530	1	-	-

Table III. Sequence 2 air observation post coverages

STANO device	Time	Number	Portion of area covered by all systems *
Helicopter observer with binoculars	0200	2	1.48
	0215	1	0.76
	0230	2	1.43
	0245	2	1.10
	0300	2	1.20
	0315	2	1.00
	0330	2	1.00
	0345	2	1.48
	0400	1	0.51
	0415	2	1.73
	0430	1	0.27
	0445	2	1.75
	0500	1	0.30

* Value may exceed 1.0 if area is covered more than once.

Table IV. Sequence 3 (night) SLAR coverages

STANO device	Time	Number	Portion of area covered by all systems
Mohawk aircraft with SLAR	0015	1	1.00
	0030	1	0.67
	0045	1	1.00
	0100	1	0.52

Table V. Sequence 3 (day) air observation post coverages

STANO device	Time	Number	Portion of area covered by all systems *
Helicopter observer with binoculars	0400	2	1.8
	0415	2	1.4
	0430	2	1.4
	0445	2	1.4
	0500	2	1.8
	0515	2	1.4
	0530	2	1.6
	0545	2	1.7
	0600	2	1.4

* Value may exceed 1.0 if area is covered more than once.

difference was the level of resolution of the units played during the reconstruction. Since the Red threat was composed only of one reconnaissance battalion, this portion of the sequence was reconstructed at the company level. The second difference was that the movement of the Red units was parallel to the Blue SL; thus, it was not necessary to reconstruct the movement of the Red units because their distance was relatively constant from the SL. As shown in table II the last difference is that the STANO devices were deployed at the beginning of the portion of the sequence and were not extracted.

(7) The reconstruction of sequence 3 (day) differed in only two respects from that of sequence 2. One difference was in the data available on the Red units. The sequence 3 gaming report contained data on the Red force only down to the brigade level. It was necessary to develop the positions for the battalions and support units for each brigade. This procedure allowed sequence reconstruction at the same level of resolution as sequence 2. The other difference was that according to the gaming report the uniform speed assumption for time/position interpolation was valid; therefore, there was no need to develop the speed compensation factor as in sequence 2.

e. STARMAN-C Application.

(1) It was necessary to make additional assumptions during the STANO evaluations beyond those normally necessary for STARMAN-C application (appendix A). These additional assumptions are as follows:

(a) The only STANO devices available to the 101st Division in these analyses were those equipments currently onhand in its units (HLC Phase I study constraint).

(b) All STANO devices available to the Blue force were in an operable state when deployed.

(c) All pieces of like STANO devices were deployed at the same average distance from the SL (except LRRPs).

(d) In the sequence 2 evaluation, when the Red forces were confined to the road, only the STANO devices capable of covering the road were allowed to make target detections.

(e) SLAR was not flown during sequence 2 and sequence 3 (day). In sequence 2, friendly foreign forces were passing through the Blue force lines; thus, SLAR information would be cluttered during the period. The SLAR was not flown in sequence 3 (day) because of its suspected vulnerability to Red aircraft during daylight.

(f) During the transcription of the Red forces from the map overlays to the STARMAN-C target input forms, each unit, at the level of resolution of the sequence, was represented by a point. This point represented the centroid of the unit's components. When a unit's position fell within a detection band, all of the resources of that unit were allocated to that band for detection.

(2) Three general types of data are input to STARMAN-C: game inputs, sensor inputs, and target inputs.

(a) The game inputs are variables defined prior to each application run. The game inputs used during each sequence evaluation are depicted in table VI. The principal sources of information for these variables were the gaming reports and the judgment of the STANO evaluation study team members.

Table VI. Game input parameters

Game input	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
Number of detection bands (DB)	20	20	20
Distance covered by DBs (kilometers)	40	20	20
Length of SL (kilometers)	20	30	30
Terrain type	Smooth	Smooth	Smooth
Country	Mideast	Mideast	Mideast
Yearly seasonal quarter	Third	Third	Third
Time of day	0200-0500	2400-0100	0400-0600
Begining morning civil twilight	0213	0221	0221
End evening civil twilight	1656	1646	1646
Moonlight	N/A	No	N/A
Terrain masking factor	Open	Open	Open
Target-terrain contrast	High	High	High

(b) Other STANO sensor inputs that require definition prior to each run are the sensor deployment parameters. These sensor inputs are in addition to those found in tables II through V, which define the number of operable Blue sensors for each snapshot, and are found in table VII. The primary sources for the values assigned to these parameters were interviews with the Blue team members of the CAC Jiffy games.

(c) The final type of input required for a STARMAN-C run is the target input array. Several steps are involved in the process that builds these target inputs for STARMAN-C.

1. The first step is to develop a STARMAN-C detection band grid. A schematic of the grid used in the sequence 2 evaluation is shown in figure 2. In this sequence the grid begins at the SL corresponding to phase line (PL) APPLE and extends for 20 kilometers. The road, upon which the Red forces are confined, is perpendicular to the SL and approximately bisects the grid. Each detection band is parallel to the SL and each extends 2 kilometers in depth. The grid for the remaining evaluations of sequence 3 is similar to that for sequence 2 except that the SL extends 30 kilometers along PL ORANGE in front of the Blue unit 2-327 Bn, and each detection band extends 1 kilometer in depth.

2. In the next step, the resources of each target unit are allocated to the detection band in which their (centroid) point is located. This step is accomplished by superimposing the STARMAN-C grid over each snapshot overlay to determine within which band each unit point falls. The resources are then tallied on the STARMAN-C target input forms.

Table VII. Sensor deployment characteristics

Sensor type	Parameter	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
BNRDR	Sweep angle (degrees)	90	60	60
	Deployment distance behind SL (kilometers)	0	0	0 and 3
SLAR	Deployment distance behind SL (kilometers)	N/A	45	N/A
GOP	Deployment distance behind SL (kilometers)	N/A	N/A	3
LRRP	Number in detection band (DB)	1 in DB 9	4 in DB 3	4 in DB 3
		1 in DB 11	3 in DB 2	3 in DB 2
		-	1 in DB 1	1 in DB 1
	Night observation device	CSWS*	CSWS*	CSWS*
AOP	Deployment distance	10 km in front of SL	N/A	3 km behind SL

*AN/TVS-2 crew served weapons sight

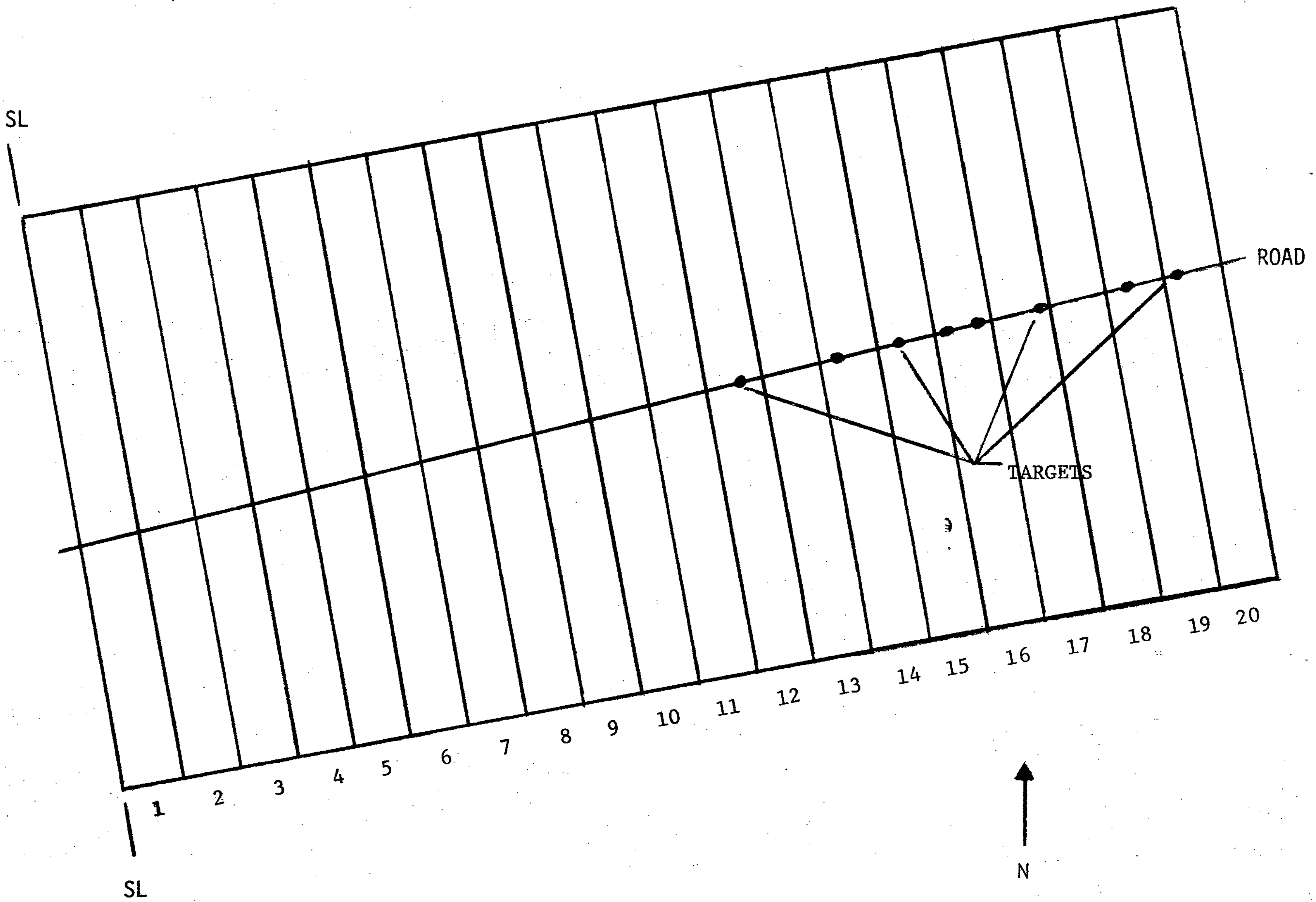

Figure 2. Detection band grid schematic

3. Next, the target input data deck is punched from the forms.

4. In the last step the card data deck and the STARMAN-C target preprocessor (PRESTAR) are used to build a target data file accessible by STARMAN-C during a run.

(3) After all three types of data have been prepared for each snapshot, the target detections that the operable STANO sensors are capable of making can be determined by application of STARMAN-C.

(4) Twenty-six STARMAN-C runs were made in support of all three evaluations. The time period investigated for sequence 2 required 13 runs, sequence 3 (night) required 4 runs, and sequence 3 (day) required 9 runs. A sample STARMAN-C output for each sensor type is contained in appendix C. Tabular STARMAN-C output for all 26 runs is contained in appendix D.

4. MEASURES OF EFFECTIVENESS.

a. Essential Elements of Analysis/Measures of Effectiveness.

(1) The five essential elements of analysis (EEA) used in this study are as follows:

(a) EEA 1. What is the measured <u>completeness</u> of the detection information provided by the sensor system?

(b) EEA 2. What is the measured <u>accuracy</u> of the detection information provided by the sensor system?

(c) EEA 3. What is the measured <u>timeliness</u> of the detection information provided by the sensor system?

(d) EEA 4. What is the measured contribution of each sensor type to the sensor system?

(e) EEA 5. What surveillance blindspots (detection voids) exist in sensor system coverage of the battle area?

(2) The first three EEAs are addressed by the measures of effectiveness (MOE) contained in table VIII. The MOEs shown in this table are divided into the categories of completeness (EEA 1), accuracy (EEA 2), and timeliness (EEA 3). The MOEs addressing EEA 4 are contained in table IX. These MOE are categorized the same as those in table VIII. The STANO device with which they are associated is identified by mention of a specific sensor system, such as SLAR, AOP, GOP, LRRP, or BNRDR, in the statement of the MOE. The fifth EEA is addressed by the tables contained in appendix F. From these tables the frequency in percentage of target elements detected was determined for each detection band. These results are illustrated in figures presented in subparagraph b below.

(3) Most of the MOEs are self-explanatory with the aid of the definitions in paragraph 3c above; however, the following equations will be helpful in understanding how the values for the MOE were obtained. The equations describe the basic MOEs used in the analysis. Detailed MOEs for a particular target or sensor type required only obvious minor changes.

- Percent of targets/elements detected =

$$\frac{\text{Number of targets/elements detected}}{\text{Number of targets/elements presented}} \times 100 \qquad (1)$$

- Target/element redundancy ratio =

$$\frac{\text{Total number of detections}}{\text{Number of targets/elements detected}} \qquad (2)$$

Table VIII. Overall system measures of effectiveness

Measure of effectiveness	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
Completeness:			
1. Total number of detections	70	102	732
2. Number of elements detected	40	29	487
3. Number of elements presented	625	58	806
4. Percent of elements detected	6.4	50.0	60.4
5. Element redundancy ratio	1.75	3.52	1.50
6. Number of targets detected	12	12	51
7. Number of targets presented	64	13	60
8. Percent of targets detected	18.8	92.3	85.0
9. Target redundancy ratio	5.83	7.84	14.35
Accuracy:			
Mean detected target CPE (meters)	112	141	88
Timeliness:			
1. Average age of detection (minutes)	5	44	5
2. Average time to first detection (minutes)	74	18	13
3. Mean range from SL at first detection (kilometers)	23	4	8

Table IX. Detailed measures of effectiveness (continued next page)

Measure of effectiveness	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
Completeness:			
1. Stationary tank targets detected (percent	0	-	-
2. Moving tank targets detected (percent)	33	-	100
3. Stationary mechanized targets detected (percent)	0	-	-
4. Moving mechanized targets detected (percent)	7	-	92
5. Stationary artillery targets detected (percent)	1.4	-	0
6. Moving artillery targets detected (percent)	15.6	-	60
7. Stationary reconnaissance targets detected (percent)	0	-	-
8. Moving reconnaissance targets detected (percent)	0	100	-
9. Stationary headquarters targets detected (percent)	0	0	-
10. Moving headquarters targets detected (percent)	21	-	89
11. SLAR relative worth (percent)	-	100	-
12. AOP relative worth (percent)	75	-	71
13. GOP relative worth (percent)	-	-	55
14. LRRP relative worth (percent)	55	15	69
15. BNRDR relative worth (percent)	0	77	96

Table IX. Detailed measures of effectiveness (continued)

Measures of effectiveness	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
16. SLAR target redundancy ratio	-	5.69	-
17. AOP target redundancy ratio	7.77	-	4.05
18. GOP target redundancy ratio	-	-	5.53
19. LRRP target redundancy ratio	2.17	2.00	3.20
20. BNRDR target redundancy ratio	0	2.80	6.48
Accuracy:			
1. Mean SLAR detection CPE (meters)	-	176	-
2. Mean AOP detection CPE (meters)	112	-	112
3. Mean GOP detection CPE (meters)	-	-	112
4. Mean LRRP detection CPE (meters)	112	112	112
5. Mean BNRDR detection CPE (meters)	-	40	40
Timeliness:			
1. Average age of SLAR detections (minutes)	-	60	-
2. Average age of AOP detections (minutes)	5	-	5
3. Average age of GOP detections (minutes)	-	-	5

Table IX. Detailed measures of effectiveness (concluded)

Measures of effectiveness	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
4. Average age of LRRP detections (minutes)	5	5	5
5. Average age of BNRDR detections (minutes)	-	4	4
6. Average time to SLAR detection (minutes)	-	5	-
7. Average time to AOP detection (minutes)	108	-	27
8. Average time to GOP detection (minutes)	-	-	85
9. Average time to LRRP detection (minutes)	35	15	4
10. Average time to BNRDR detection (minutes)	-	10	30
11. Mean range from SL at first SLAR detection (kilometers)	-	4	-
12. Mean range from SL at first AOP detection (kilometers)	21	-	7
13. Mean range from SL at first GOP detection (kilometers)	-	-	3
14. Mean range from SL at first LRRP detection (kilometers)	25	3	7
15. Mean range from SL at first BNRDR detection (kilometers)	-	4	7

. Mean detected target CPE =

$$\frac{\sum_{\text{all } i} CPE_i}{\text{Total number of detections}} \tag{3}$$

. Average age of detection =

$$\frac{\sum_{\text{all } i} age_i}{\text{Total number of detections}} \tag{4}$$

. Average time to first detection =

$$\frac{\sum_{\text{all } i} (\text{time of first detection - start time})_i}{\text{Number of targets detected}} \tag{5}$$

. Mean range from SL at first detection =

$$\frac{\sum_{\text{all } i} range_i}{\text{Number of targets detected}} \tag{6}$$

. Relative worth of the sensor type =

$$\frac{\text{Number of targets detected by this sensor type}}{\text{Number of targets detected by all sensors}} \times 100 \tag{7}$$

(4) The equation given for the redundancy ratio (equation 2) is different from that normally used for this measure. Redundancy ratio normally reflects the average number of times a target is reported. Since

STARMAN-C gives the number of target elements reported and not the number of target reports, this definition was modified for this analysis. The target/element redundancy ratios in this analysis are effectively the average number of target element detections for each different target/element detected.

(5) Early warning capabilities of the sensor systems are examined by the MOEs in the timeliness category. Average age of detection is the mean length of time necessary to process and transmit a detection to the tactical operations center (TOC); for example, there is a 60-minute delay for the side-looking airborne radar (SLAR) detections because film must be developed to locate the enemy units, then this information must be hand-carried or radioed to the TOC. The average time to detection is a measure of the mean time from the beginning of the exercise to the first detection of each target that is detected. One of the most important measures of early warning capability to a commander is the mean range from the SL at first detection. These three types of MOEs make up the timeliness category. Of course, only detected target information could be used in these calculations. Targets that were not detected have no impact on the timeliness MOEs.

b. Evaluation of the MOEs.

(1) The measures of effectiveness were calculated from the inputs and outputs of the STARMAN-C model and modifications thereof. In order to evaluate the MOEs, it was necessary to identify company and, in one

instance, platoon-sized targets that were present as the largest maneuver units in each band for each time period from the model input information. These company/platoon targets were categorized as to the type of unit; i.e., headquarters, tank, mechanized, reconnaissance, or artillery targets. All pieces of equipment for each target were identified and assigned a unique identification number. Then, a random number generated by the model for each piece of equipment detected in a detection band was compared to the identification numbers of each target element to determine to which company/platoon the equipment belonged. Thus, in this analysis, the detection of one target element was sufficient information to detect that company/platoon. For example, if a truck belonging to a headquarters company was detected, the headquarters was detected. Once the detected targets were identified, the measures of effectiveness could be calculated using the equations described above.

(2) The values of the measures of effectiveness are shown in the two tables presented earlier. Table VIII lists the overall measures of effectiveness for the total STANO capability of the combined sensor systems of the 101st Division. Table IX contains the detailed measures of effectiveness for each type of sensor system.

(3) Appendix D contains a tabulation of the STARMAN-C output for each scenario with an added column for the target ID numbers, which were calculated manually from the troop lists and the computer-generated random number column. Appendix E contains the first detection tables

for each scenario. These tables contain the time and range band of first detection for all targets and sensor types in the scenario. The data in this appendix were used to generate the MOEs under the timeliness category in table IX.

(4) Figures 3 through 5 depict the percent of targets detected over the whole sequence (frequency) as a decimal fraction versus the range of the targets from the SL in kilometers for each scenario. These figures indicate the frequency or percentage of targets passing through each detection band that were actually detected. Figures 6 through 13 show the average percent of target elements detected over a 15-minute period versus range, rather than percent of targets versus range. The labels on the graphs indicate the scenario and type element to which the graphs pertain. These graphs were generated in response to EEA 5. Blindspots in the detection capability of the mix of STANO equipment can be identified by inspection of figures 3 through 5 for target voids and figures 6 through 13 for voids due to particular target elements. The program used to generate these figures on the desk-top HP 9830A calculator is given in appendix F. The tables from which these graphs were plotted also are shown in appendix F.

5. ANALYSIS OF RESULTS.

a. EEA Evaluation. Measures of effectiveness pertaining to the five essential elements of analysis described in paragraph 4a above were calculated as shown in the preceding discussion for three different sequences. The differences in MOE values among sequences, some of which are large, can be accounted for by the differences among sequences in numbers and

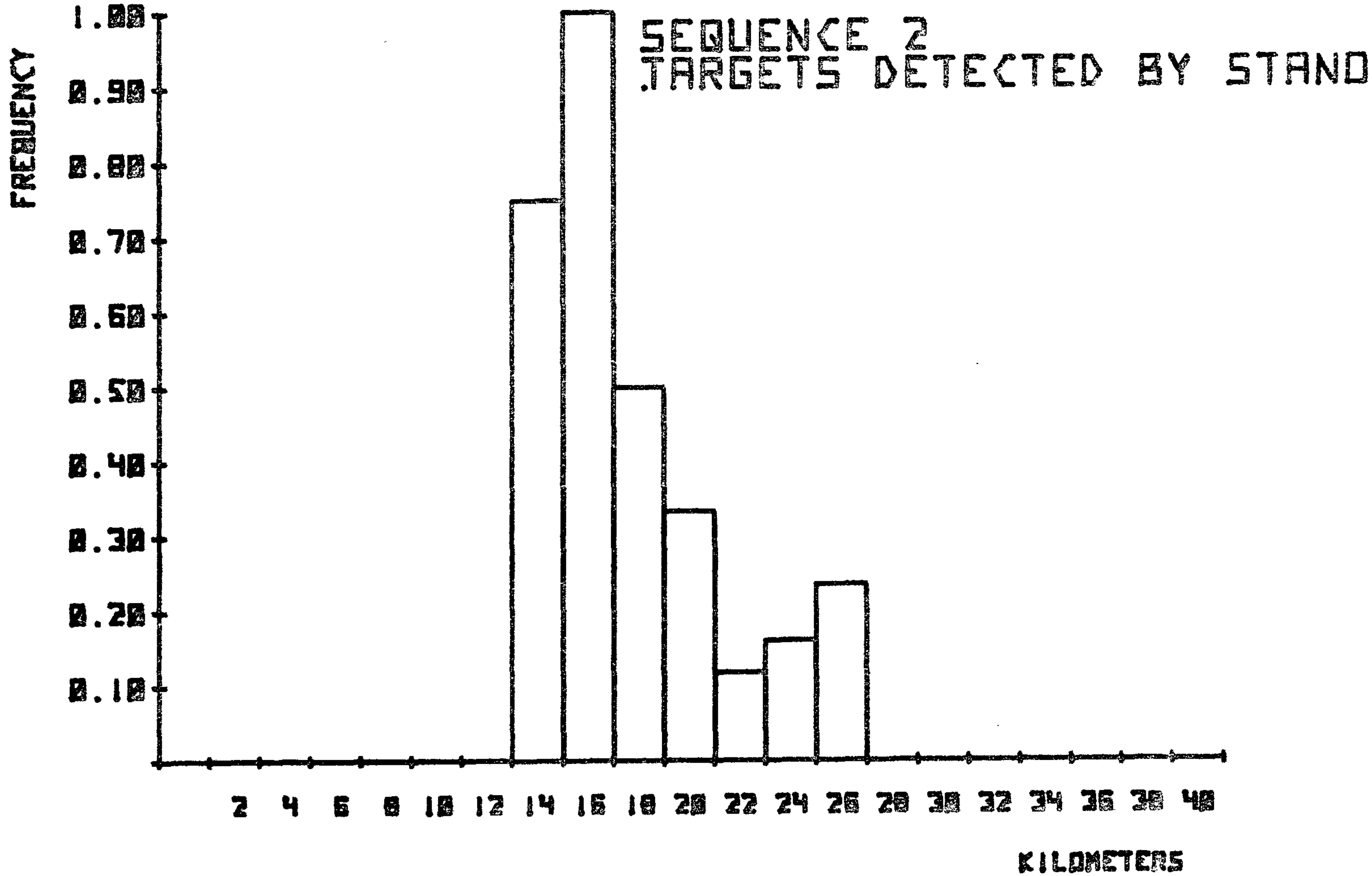

Figure 3. Histogram of sequence 2 target detections

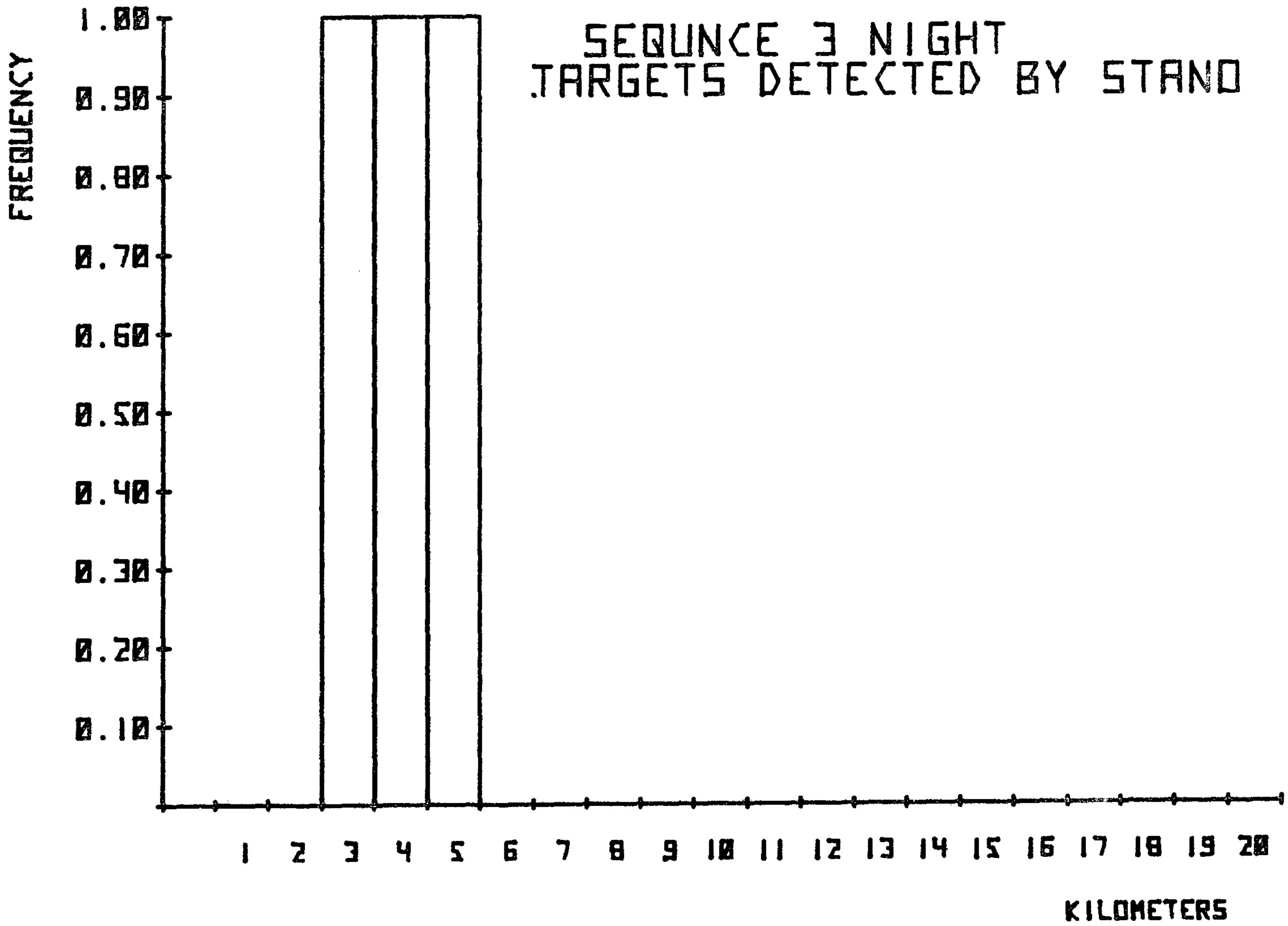

Figure 4. Histogram of sequence 3 (night) target detections

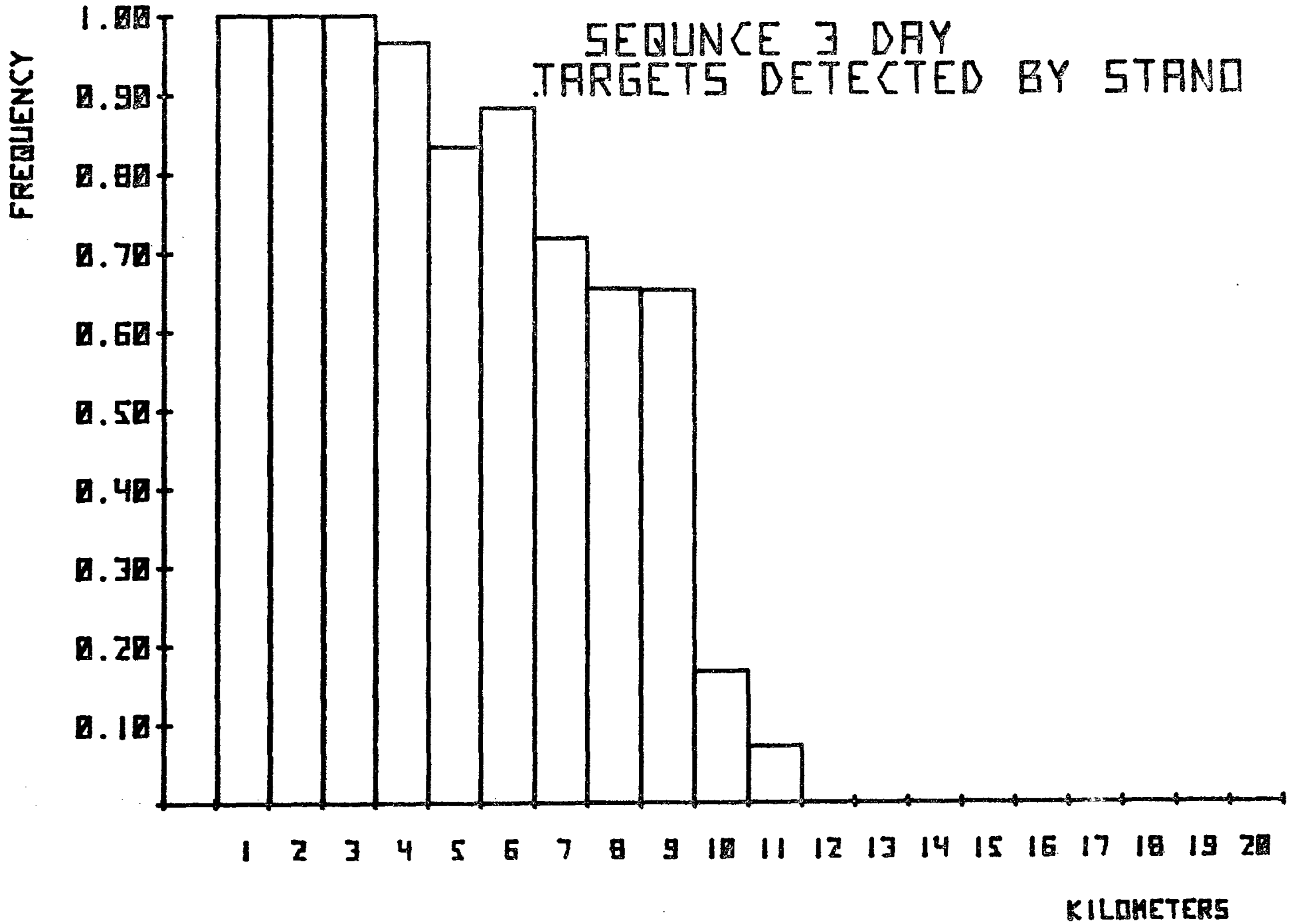

Figure 5. Histogram of sequence 3 (day) target detections

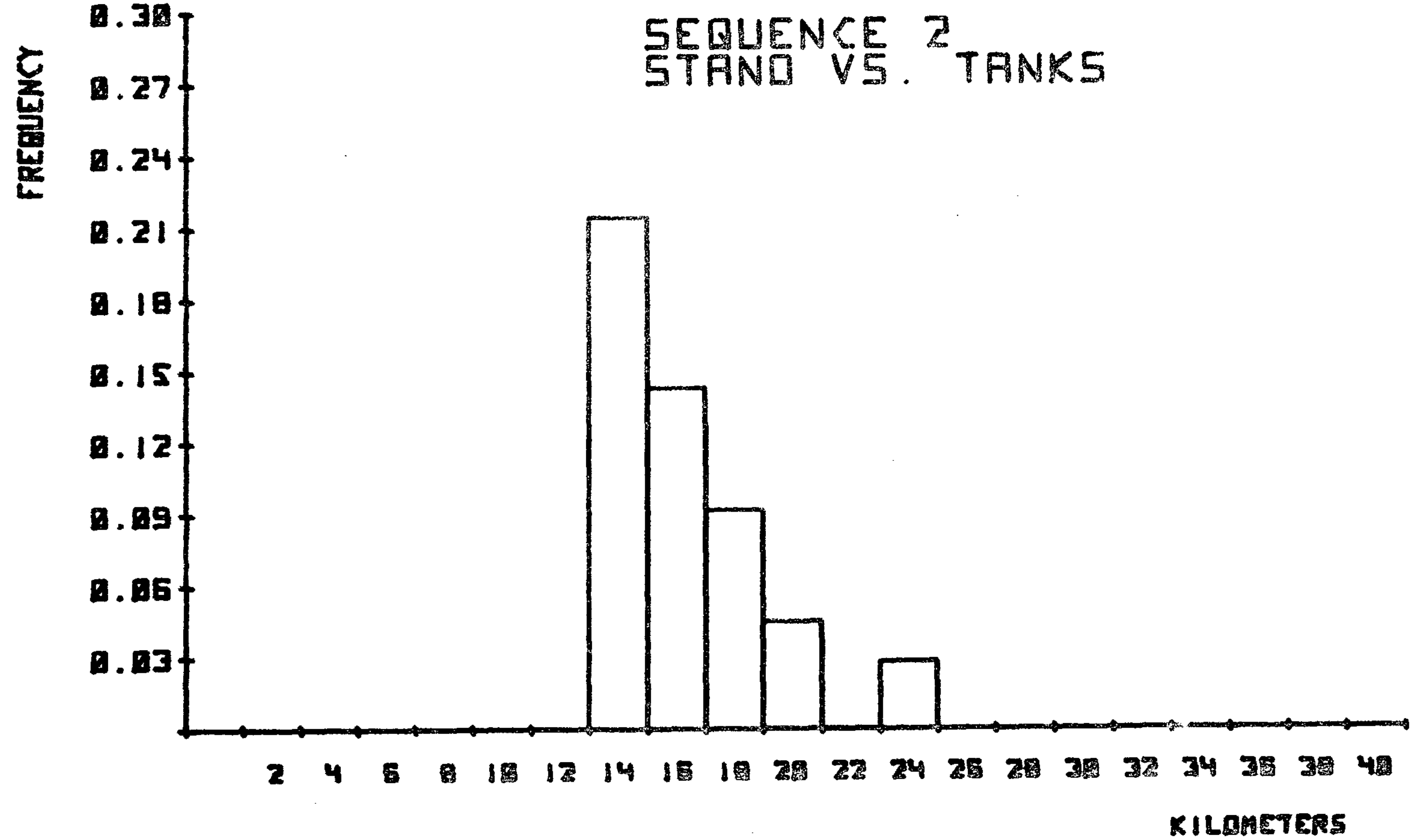

Figure 6. Histogram of sequence 2 tank element detections

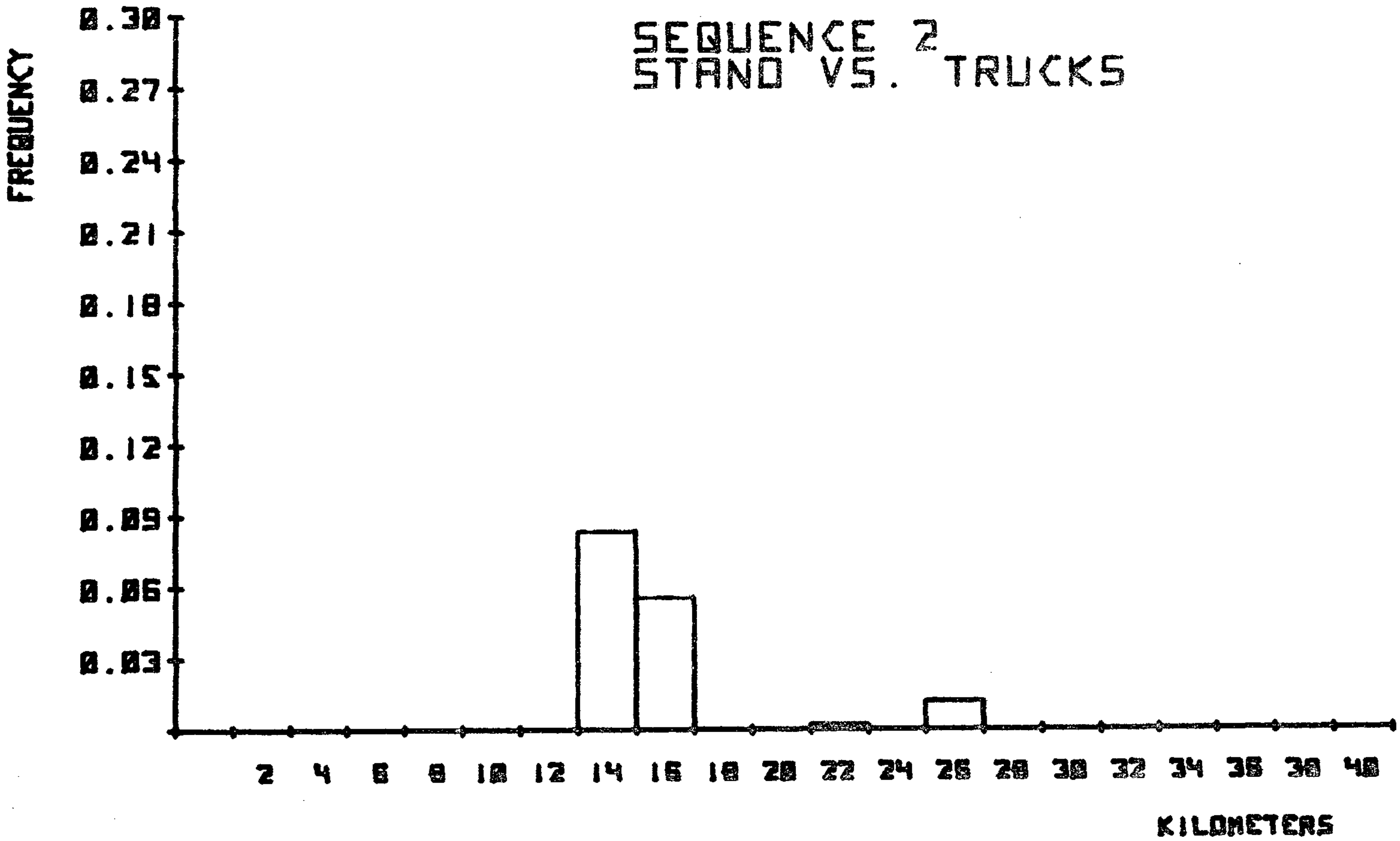

Figure 7. Histogram of sequence 2 truck element detections

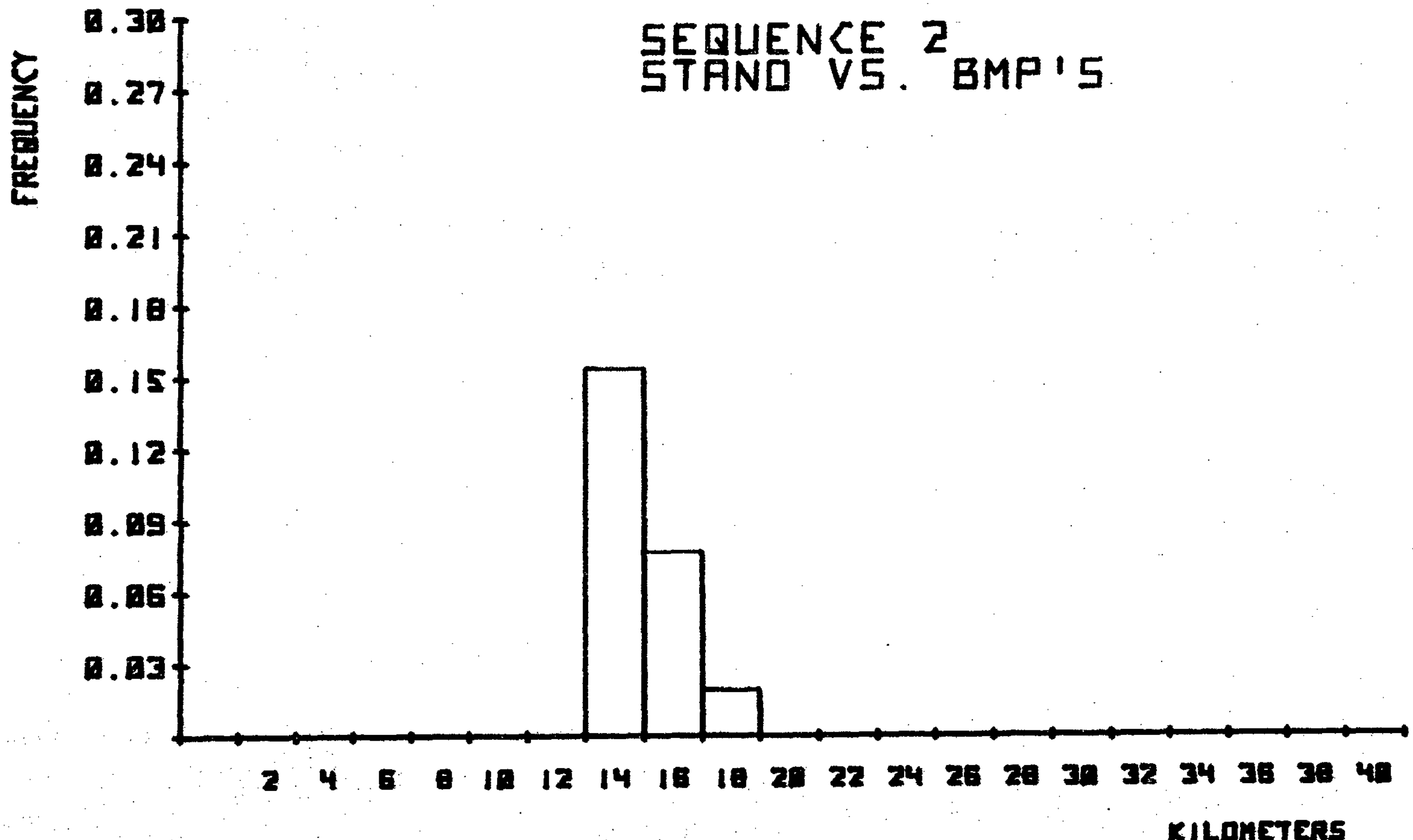

Figure 8. Histogram of sequence 2 BMP element detections

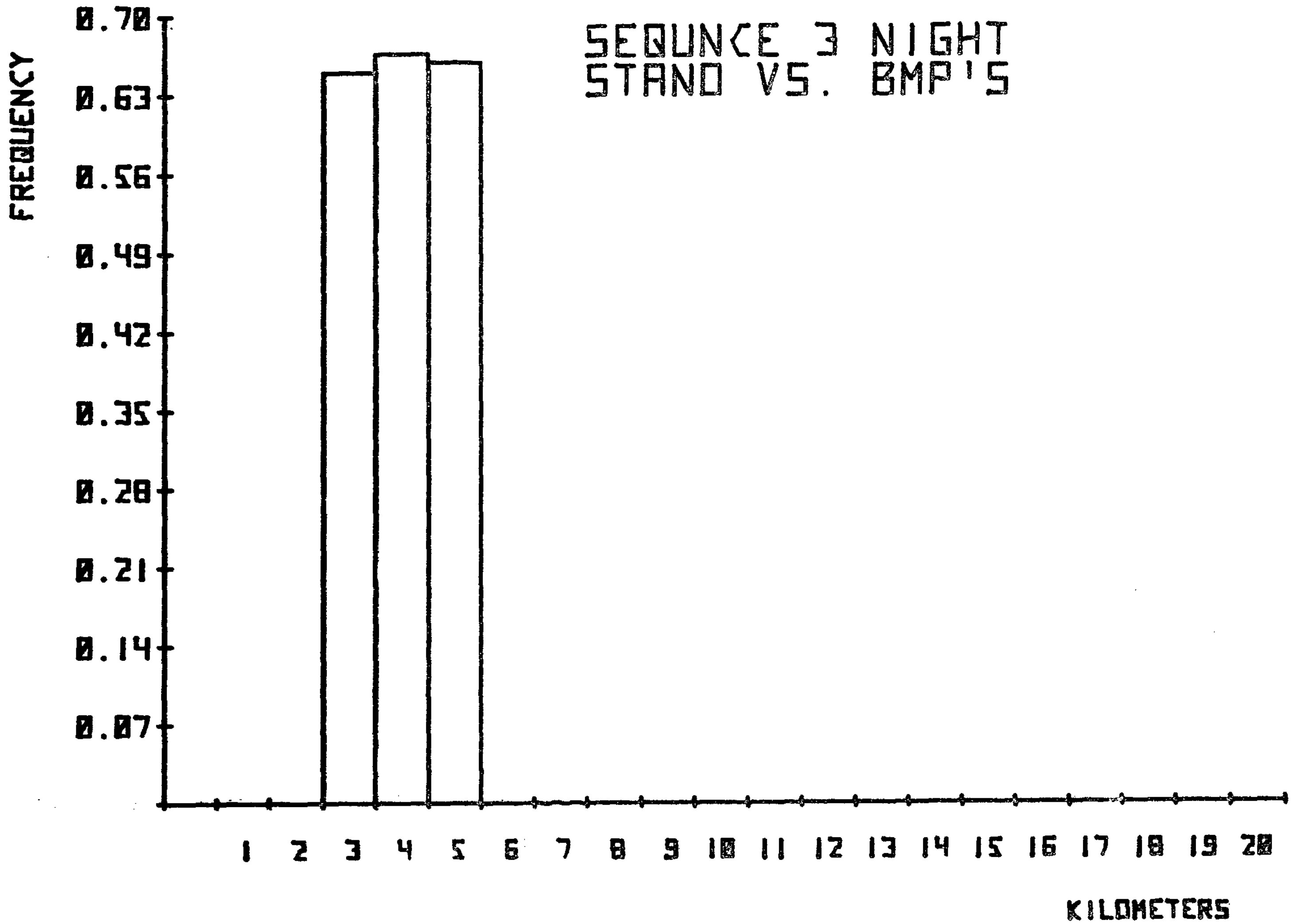

Figure 9. Histogram of sequence 3 (night) BMP element detections

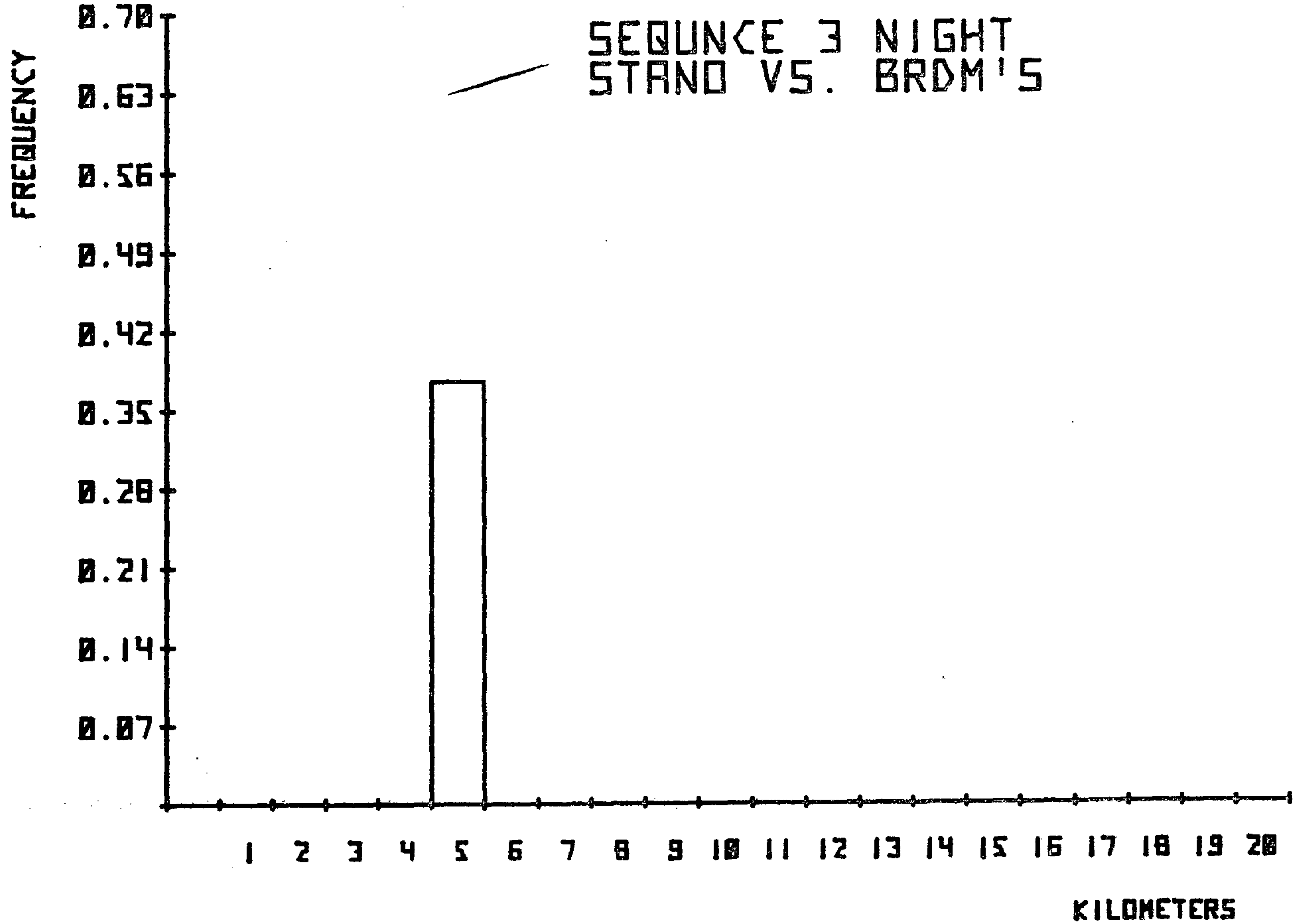

Figure 10. Histogram of sequence 3 (night) BRDM element detections

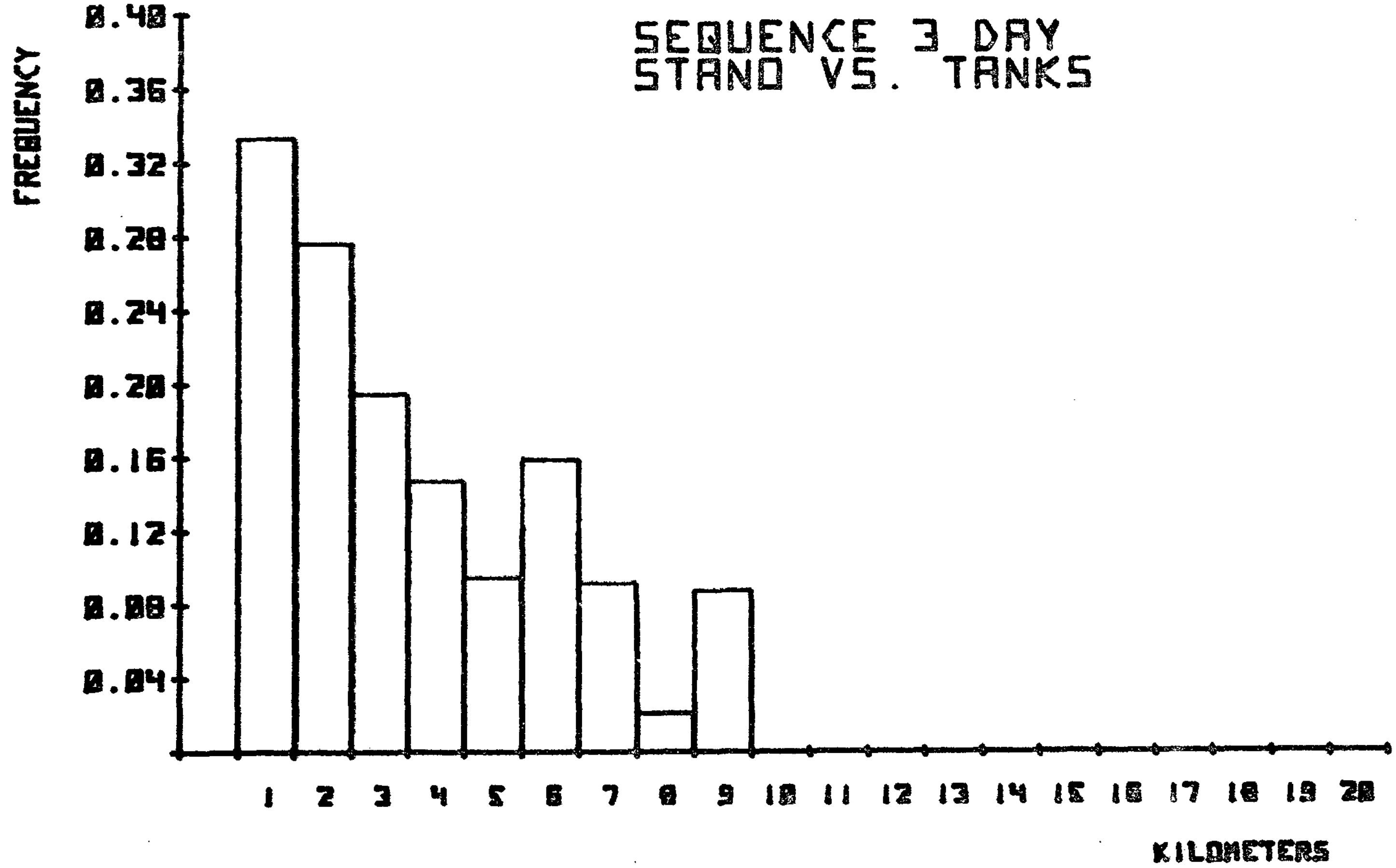

Figure 11. Histogram of sequence 3 (day) tank element detections

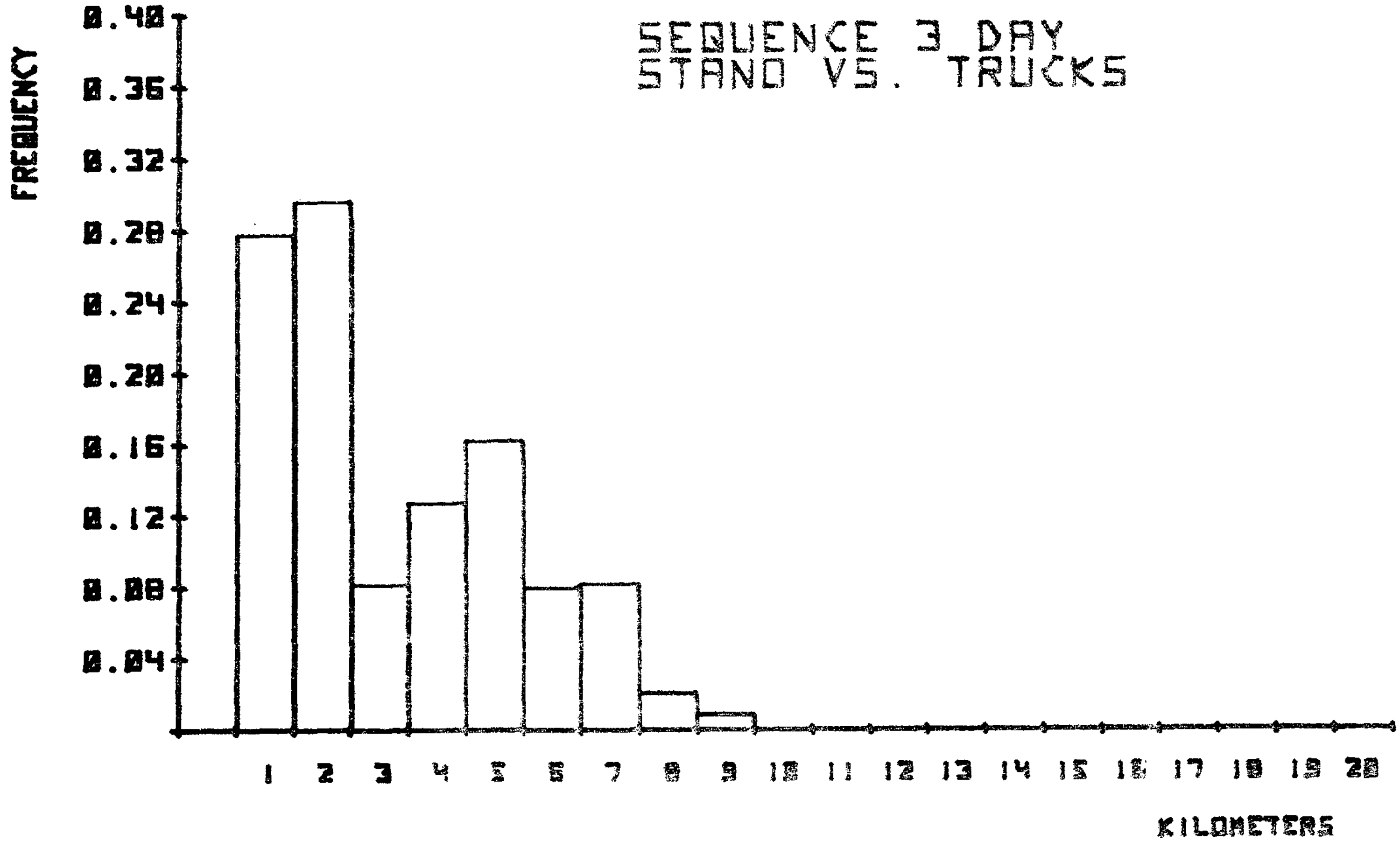

Figure 12. Histogram of sequence 3 (day) truck element detections

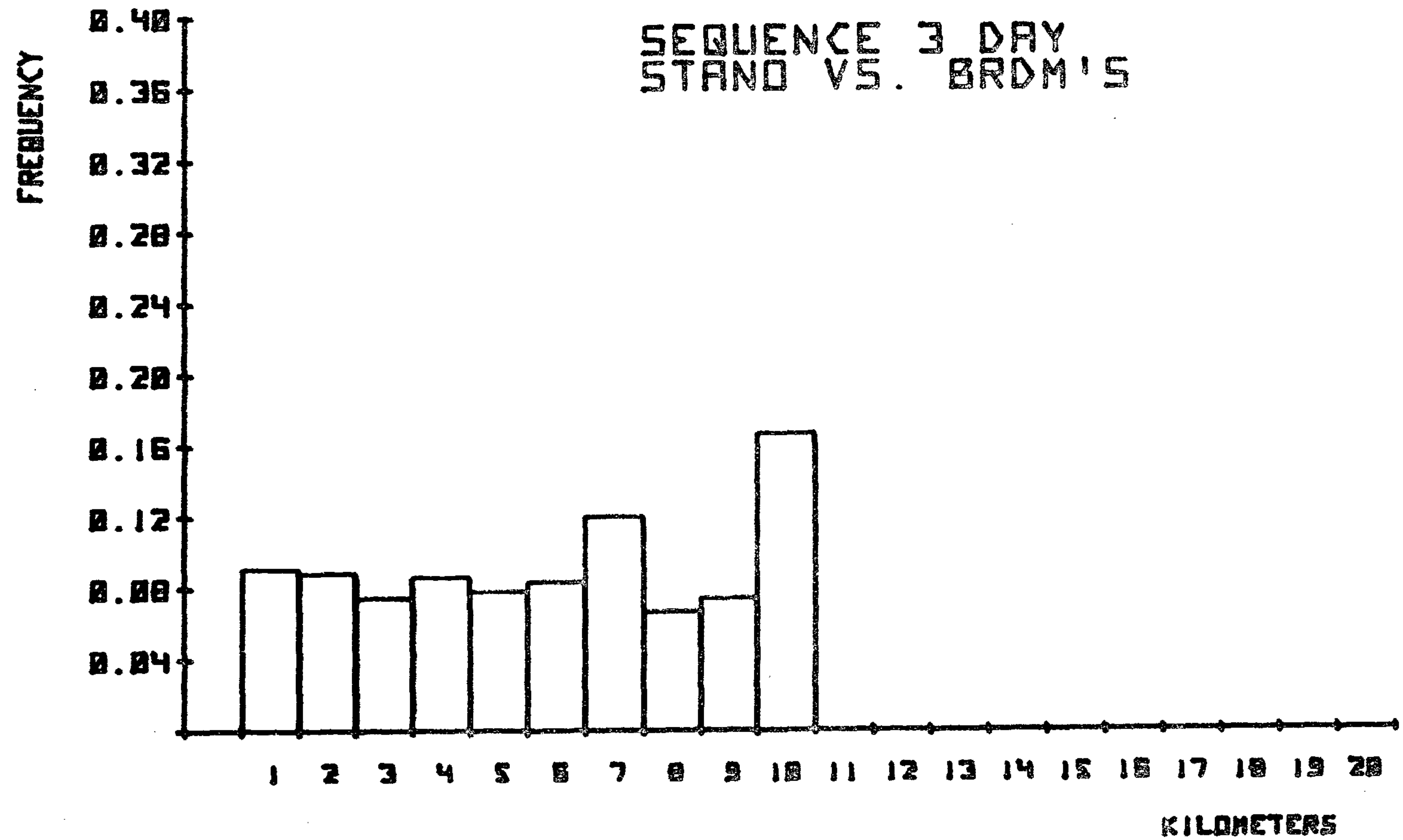

Figure 13. Histogram of sequence 3 (day) BRDM element detections

types of equipment, average target distance from the line of surveillance, and the length of time over which the sequences were modeled, as shown in table X.

(1) EEA 1. What is the measured completeness of the detection information provided by the sensor system? From table VIII, 18.8 percent of the company-sized targets were detected at least once during the 3.25 hours of sequence 2 simulation. Compared to 100 percent and 85 percent for sequence 3 (night) and sequence 3 (day), respectively, this was the lowest percentage of completeness of the three sequences. Sequence 2 also had the lowest target redundancy ratio, 5.83, compared to 7.84 for sequence 3 (night) and 14.35 for sequence 3 (day). Sequence 3 (night) and sequence 3 (day) sensor systems performed much better primarily because a larger amount of equipment was used at much closer ranges. Inspection of the detailed completeness MOEs contained in table IX reveals several prominent facts. First, in the sequences in which tank targets were present, the percentage of tank targets detected was higher than any other type of target. Second, stationary targets (except sequence 2 stationary artillery targets) were not detectable by the evaluated STANO systems. It should be noted that a target could be in a stationary mode in one snapshot and in a moving mode in the next; for example, MOE 1 of table IX shows that of the tank targets presented, 0 percent were detected while stationary; however, MOE 2 indicates that 33 percent of the tank targets presented were detected while moving. Further inspection reveals that in the one sequence in which the SLAR was used, sequence 3 (night), it out-performed (with respect to completeness) all the other sensors in that sequence combined, due to its high probability of detection.

Table X. Differences among scenario sequences

Item	Sequence 2	Sequence 3 (night)	Sequence 3 (day)
Number of SLAR in operation	-	1	-
Number of AOP in operation	2	-	2
Number of GOP in operation	-	-	8
Number of LRRP in operation	2	8	8
Number of BNRDR in operation	3	5	7
Average target distance from SL (kilometers):			
Starting	30.0	4.4	8.5
Ending	26.9	4.4	4.9
Length of sequence (hours)	3.25	1.0	2.25

(2) EEA 2. What is the measured accuracy of the detection information provided by the sensor system? The mean detected target CPE varied from 88 meters in sequence 3 (day) to 141 meters in sequence 3 (night) as shown in table VIII. Table IX reveals that the poor accuracy characteristics of the SLAR (176-meter CPE) raised the average overall CPE in sequence 3 (night). The CPE in sequence 3 (day) was enhanced by the accuracy of the battalion radars (40-meter CPE). The average accuracies of the AOP, GOP, and LRRP were approximately equal at 112-meter CPE.

(3) EEA 3. What is the measured timeliness of the detection information provided by the sensor system? Three types of MOE address this EEA: average age of detection, average time to detection, and mean range from SL at first detection. The large differences in the last type of MOE are due to the wide variation in starting and ending target distances from the surveillance line in the sequences. The difference between the average age of detection and the average time to detection should be noted. The average age of detection is the average period of time necessary to process and transmit a detection to the TOC. The SLAR scores worst in this area at 60 minutes, and the other sensors are approximately equal at 4 minutes (BNRDR) and 5 minutes (AOP, GOP, and LRRP). The average age of detection in the sequence 3 (night) analysis was increased to 44 minutes (table VIII) from the 5-minute average in the other two sequences by a large number of SLAR detections. The average time to detection is the mean length of time after the start of the scenario until the first detection of each target that was detected. Sequence 2 time to first detection of 74 minutes (table VIII) was much longer than the sequence 3 (night) and sequence 3 (day) scenarios, 18 and 13 minutes

respectively, because the targets in sequence 2 started much further from the SL than the others. In table IX it can be seen that the LRRPs and SLARs had the shortest time to detection (4 and 5 minutes respectively). This result partially compensates for the SLAR's high average age of detection.

(4) EEA 4. What is the measured contribution of each sensor type to the sensor system? The contributions of each sensor type in the areas of accuracy and timeliness were discussed in EEAs 1, 2, and 3 above. In the area of completeness, the value of each sensor type is expressed as the relative worth of that sensor type in table IX. The relative worth of the SLAR in the one sequence in which it was used is 100 percent. The battalion radars also scored relatively high in the two sequences where the targets were within radar range. In sequence 2, where the targets were out of radar range, the relative worth of the BNRDR is zero. Two AOPs were used in sequence 2 and in sequence 3 (day). The relative worths of the AOP in these scenarios are consistent (75 percent and 71 percent). Ground observation posts were used in sequence 3 (day) only. Their relative worth is 55 percent. LRRPs were used in all three sequences. LRRP relative worths varied between 15 and 69 percent. The 15 percent relative worth, which occurred in sequence 3 (night), was attributed to the LRRPs use of the crew served weapons sights for aid in night observation.

(5) EEA 5. What surveillance blindspots (detection voids) exist in the sensor system coverage of the battle area? Inspection of figures 3 through 5 reveals that the detection bands in which complete voids in

the detection capabilities for company/platoon-sized targets existed for the sensor mix used in these evaluations were generally the detection bands furthest from the SL. As illustrated in these figures, a large percentage of the forwardmost enemy unit targets were detected. This percentage generally decreased as the range from the surveillance line increased. Figure 4 does not follow this trend because the SLAR detected all of the moving targets in that sequence; when no targets were present in the detection bands closest to the SL, their cell frequency was zero. Examination of figures 6 through 13 reveals, as expected, the same general high to low percentage characteristic exhibited by the previous figures, with the notable exceptions being figures 9, 10, and 13. The exceptions of figures 9 and 10 may again be attributed to the high detection capability of the SLAR; however, figure 13 shows the capability of the STANO mix used in sequence 3 (day) (AOP, GOP, and BNRDR) to detect BRDMs was relatively independent of their range from the SL.

b. Insights.

(1) The most obvious insight to be gained from the MOE tables is the potential value of the SLAR in the Mideastern terrain for surveillance purposes. The high average age of SLAR detections (60 minutes) and high mean SLAR detection CPE (176 meters) may preclude it from becoming a good target acquisition tool in mobile scenarios, but for surveillance purposes the long range of the SLAR and its high probability of detection (100 percent relative worth in sequence 3 (night))make it a major contributor to the overall surveillance picture.

(2) The detailed completeness MOEs of table IX indicate that the STANO equipments of the 101st Division, as configured in the

sequences evaluated, were unable to effectively detect stationary targets. The single stationary detection (sequence 2 stationary artillery target) was the detection of a stationary truck made by a forward ground observer (LRRP) before the Red advance was initiated. Even though the sequences evaluated were highly mobile in nature, this lack of detectability for stationary targets is considered to be a limitation of the STANO capabilities of the 101st Division.

(3) Another easily discernible insight gained in the evaluation was the absence of detection of artillery tubes. This result can be attributed to the fact that the 101st Division does not have any artillery locating STANO devices integral to its units. The artillery targets that were detected, as evidenced by completeness MOE 16, in table IX, were moving trucks assigned to the artillery units. No firing artillery tubes were detected. The largest amount of Red fire support in the sequences evaluated was provided by their artillery assets. These systems inflicted more casualties and damage than any other Red weapon system. It is apparent that this void in its STANO capabilities is a serious limitation to the operability of the 101st Division in this environment.

(4) In both sequences where tank targets were present, a larger percentage of moving tank targets was detected than any other type of target; therefore, targets containing tanks are more likely to be detected than targets with no tanks.

(5) Since this was the first application of STARMAN-C, several needed improvements were exposed, such as simplifying the method of target input and altering the output variables to reflect additional

pertinent information; however, even in its present configuration, STARMAN-C proved an adequate tool for STANO evaluations.

6. CONCLUSIONS.

a. The SLAR is the most effective STANO device with regard to the completeness EEA but is deficient in the accuracy and timeliness categories. SLAR's timeliness and accuracy characteristics are adequate for surveillance purposes, but in its present configuration the SLAR is inadequate for most target acquisition purposes.

b. Friendly forces suffered the most casualties and damage from enemy artillery units. The STANO devices currently in the 101st Division lacked the capability to detect the firing artillery batteries because countermortar and counterbattery locating equipment is not currently part of the 101st Division's STANO equipment.

c. The STANO configurations of the 101st Division in the sequences evaluated were ineffective against stationary targets.

d. STARMAN-C has immediate potential usefulness for STANO evaluations and enhancing Jiffy game procedures by allowing commanders to base their decisions on more realistic evaluations of their tactical situations.

7. RECOMMENDATIONS.

a. Due to the SLAR's evaluation excellence in the completeness category, a substantial increase in the surveillance information available to such units as the 101st Division could be attained by increasing the number of SLAR aircraft in the air. Thus, the number of SLAR Mohawk aircraft available to the corps assets should be increased.

b. The addition of a communications data-link between the SLAR operator in the aircraft and the TOC on ground is recommended. This addition would reduce the average age of the SLAR detections and greatly improve its effectiveness in the timeliness category, which would also allow the SLAR detections to have a greater impact on target acquisition.

c. Despite the need to be lightly equipped and highly mobile, the 101st Division should be provided with the counterbattery/countermortar assets currently available to the Army in the field (i.e., the AN/MPQ-4a countermortar/battery radar).

d. Since the performance of the AN/MPQ-4a is already considered marginal and the design of an improved replacement (AN/MPQ-37) is currently underway, it is recommended that the development of these replacements be expedited.

e. It is recommended that Combat Operations Analysis Directorate continue its efforts to complete the development of STARMAN-C as both a STANO evaluation tool and a Jiffy game improvement.

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APPENDIX A

STARMAN-C MODEL DESCRIPTION

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STARMAN-C MODEL DESCRIPTION

1. PURPOSE. Surveillance, Target Acquisition Routines for Manual War Games - Computerized (STARMAN-C) is a one-sided model that simulates the detection capabilities of various mixes of sensor systems. The model is designed to interface easily with manual war gaming due to the simplified target/sensor input data requirements.

2. DESCRIPTION.

a. STARMAN-C is a surveillance and target acquisition sensor simulator that determines the expected number of targets detected by a given sensor mix based on a snapshot, or instant of time, of a ground-truth target array. The model utilizes a data base compiled by the Army Materiel Systems Analysis Agency (AMSAA) for their division level target acquisition model. This data base has been augmented with additional data, so that STARMAN-C can currently play any number of 13 different sensor systems on 4 general types of terrain during all 4 seasons of the year, day or night. The types of sensors are: two ground-based MTI radars, SLAR with three range settings, two counterbattery radars, sound and flash ranging, three kinds of ground observation posts with optical magnification during day and night vision aids during the night, and air observation posts. The general types of terrain are smooth, rolling, hilly, and mountainous.

b. To exercise STARMAN-C the gamer defines an area of interest (AOI) for the investigation and defines its pertinent physical characteristics in the model. The AOI is a portion of scenario where a war game has generated a target ground truth array and over which the surveillance and target acquisition capabilities are to be measured. The AOI is divided into detection bands, equidistant bands from the sensors' surveillance line to the end of the area of interest. The number of targets in each detection band is tallied by target class and disposition for input into STARMAN-C. Finally, the gamer defines the number of each type of sensors operating at the snapshot for evaluation by the model.

3. MODEL STRENGTHS.

a. STARMAN-C can be used with either computerized or manual war gaming techniques. This flexibility is basically due to the feature of the model that allows any ground-truth target array to be grouped into detection bands for detections.

b. The amount of effort required for target inputs also has been held to a minimum by the detection band feature. The exact position, X and Y coordinates, of the targets is not required, only the target's presence in a detection band need be known.

c. STARMAN-C is a deterministic model that calculates the expected number of detections in each detection band by each type of sensor system being played. This approach generally allows a running time of between 1 and 2 CPU minutes, depending on the number of different types of sensors played. Considering the setup time, the turnaround time for each STARMAN-C run is less than 1 day.

d. The model has been modularly constructed to ease the deletion of sensors not required to be played in a game and the addition of new sensors not currently in the model.

e. The model will be responsive to parameter variations and sensitivity analyses for sensor mix optimization, sensor deployment concepts, terrain effects, changes in sensor detection characteristics, environmental variations, and effects of target mix and target deployment.

4. MODEL LIMITATIONS.

a. The target grouping into detection band feature necessitates the assumption of uniformity of target dispersion within the detection band. If the assumption is found to be too limiting, the width and/or length of the detection bands should be changed until the assumption is valid.

b. STARMAN-C's resolution capabilities for the sensor systems being simulated are inversely proportional to the size of the detection bands. As the width of the detection bands decreases, the resolution of the detection capabilities that the model simulates increases, and the amount of target input information required also increases.

c. The deployment configuration of one sensor is typical of all sensors of the same type. If this assumption proves limiting, each sensor may have to be gamed individually.

d. The AMSAA data base is not fully validated.

5. INPUT. Input to STARMAN-C is described below.

Data type	Preparation time	Source	Acceptability	Amount
Data Base	-	AMSAA	Unknown	9-track tape
Scenario Definition: . Scenario size . Terrain type . Number of detection bands . Physical Environment . Target contrast	1 Man-Hour	Study team from the TRADOC standard scenario	Excellent	10 cards
Meteorological conditions: . Seasonal quarter . Time of day . Moonlight	1/2 Man-Hours	Study team from dynamic scenario	Excellent	3 cards
Sensor inputs: . Number of operable sensors . Typical deployment parameters	2 Man-Hours	Study team from dynamic scenario	Excellent	10-50 cards
Target inputs: Number of each target type in each detection band	4 Man-Hours	Study team from dynamic scenario	Excellent	63 cards

6. OUTPUT. The target detection information for each of the 13 sensor types is available at the end of a STARMAN-C run for each snapshot. This information determined for all target classes detectable by each individual sensor type includes:

a. Percent of targets detected in each detection band.

b. Number of targets detected in each detection band.

c. Number of targets available for detection in each detection band.

d. Accuracy of the detections (circular probable error).

e. Detection processing time inherent to the sensor system.

f. Target game identification number for detection/target correlation.

7. MODEL VALIDATION. STARMAN-C has not been fully validated. Model results must be thoroughly investigated to insure consistency with previous studies, other models, and field experiments.

8. INDEPENDENT MODEL EVALUATIONS. Unknown.

9. MODEL HISTORY. STARMAN-C was developed for TRADOC to be used with the Combined Arms Combat Developments Activity's (CACDA) force level manual war game (Jiffy Game). It is the product of Mr. Timothy J. Bailey of the CACDA's Combat Operations Analysis Directorate (COAD). The model is currently operational on the TRADOC CDC 6500 at Fort Leavenworth for use in support of manual war gaming work.

10. MODEL USERS.

Agency	Contact	AUTOVON
CACDA	Mr. T. J. Bailey	552-5481

11. DOCUMENTATION. Formal documentation for STARMAN-C is to be developed, but its completion date is unknown.

APPENDIX B

STARMAN-C TARGET INPUT FORMS

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STARMAN-C TARGET INPUT FORMS

The forms contained in this appendix are used to compile target input data for STARMAN-C runs. Entries on these forms are made by first determining the numbers of each kind of target element played in the model in each detection band. Next, the mode (stationary, moving with velocity less than or equal to 12 KPH, or moving with velocity greater than 12 KPH) of each element is noted and the corresponding number of elements is entered in the appropriate position on the form. A different set of forms is compiled for each snapshot of ground-truth array to be evaluated by STARMAN-C.

STARMAN-C
TARGET INPUT
SHEET 1

DAY/TIME: ___

TARGET	DISPOSITION	DETECTION BAND														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	20
240 LCHR	STATIONARY															
240 LCHR	V.LE.12KPH															
240 LCHR	V.GT.12KPH															
SS-1B	STATIONARY															
SS-1B	V.LE.12KPH															
SS-1B	V.GT.12KPH															
120 MORT	STATIONARY															
120 MORT	V.LE.12KPH															
120 MORT	V.GT.12KPH															
152MM H	STATIONARY															
152MM H	V.LE.12KPH															
152MM H	V.GT.12KPH															
FROG	STATIONARY															
FROG	V.LE.12KPH															
FROG	V.GT.12KPH															
122 & 130MM H	STATIONARY															
122 & 130MM H	V.LE.12KPH															
122 & 130MM H	V.GT.12KPH															
SA-2	STATIONARY															
SA-2	V.LE.12KPH															
SA-2	V.GT.12KPH															

STARMAN-C
TARGET INPUT
SHEET 2

DAY/TIME:

TARGET	DISPOSITION	DETECTION BAND 1	2	3	4	5	6	7	8	9	10	11	12	13	1	19	20
(22) 14.5MM	STATIONARY																
(23) 14.5MM	V.LE.12KPH																
(24) 14.5MM	V.GT.12KPH																
(25) 57/2 AA	STATIONARY																
(26) 57/2 AA	V.LE.12KPH																
(27) 57/2 AA	V.GT.12KPH																
(28) 23MMAA	STATIONARY																
(29) 23MMAA	V.LE.12KPH																
(30) 23MMAA	V.GT.12KPH																
(31) 85MMAA	STATIONARY																
(32) 85MMAA	V.LE.12KPH																
(33) 85MMAA	V.GT.12KPH																
(34) PERS	STATIONARY																
(35) PERS	V.LE.12KPH																
(36) PERS	V.GT.12KPH																
(37) TANK	STATIONARY																
(38) TANK	V.LE.12KPH																
(39) TANK	V.GT.12KPH																
(40) APC	STATIONARY																
(41) APC	V.LE.12KPH																
(42) APC	V.GT.12KPH																

TARGET INPUT
SHEET 3

DAY/TIME: __

TARGET	DISPOSITION	DETECTION BAND 1	2	3	4	5	6	7	8	9	10	11	12	13	14	19	20
43) TRUCK	STATIONARY																
44) TRUCK	V.LE.12KPH																
45) TRUCK	V.GT.12KPH																
46) TRACTOR	STATIONARY																
47) TRACTOR	V.LE.12KPH																
48) TRACTOR	V.GT.12KPH																
49) ASLT G	STATIONARY																
50) ASLT G	V.LE.12KPH																
51) ASLT G	V.GT.12KPH																
52) T RTVR	STATIONARY																
53) T RTVR	V.LE.12KPH																
54) T RTVR	V.GT.12KPH																
55) BMP	STATIONARY																
56) BMP	V.LE.12KPH																
57) BMP	V.GT.12KPH																
58) BRDM	STATIONARY																
59) BRDM	V.LE.12KPH																
60) BRDM	V.GT.12KPH																
61) ATGM	STATIONARY																
62) ATGM	V.LE.12KPH																
63) ATGM	V.GT.12KPH																

APPENDIX C

STARMAN-C SAMPLE OUTPUTS FOR EACH TYPE SENSOR SYSTEM USED IN THE HLC-ME EVALUATION

APPENDIX C

STARMAN-C SAMPLE OUTPUTS FOR EACH TYPE SENSOR SYSTEM USED IN THE HLC-ME EVALUATION

This appendix contains example STARMAN-C output for all five kinds of sensor systems used in this evaluation: battalion radar (BNRD), side-looking airborne radar (SLAR), battalion observation posts (BNOP), long range reconnaissance patrols (LRRP), and air observation posts (AOP). All the STARMAN-C outputs for each evaluation can be found in tabular form in appendix D.

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**********************************************************************************
            45.
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DETECTION BAND    3
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 2  23.25 PERCENT, OR   1 OF   6 M         VEHCLE WITH CPE OF     40. M. AND DELAY    4. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    1

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DETECTION BAND    4
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 2  23.75 PERCENT, OR   2 OF  10 M         VEHCLE WITH CPE OF     40. M. AND DELAY    4. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    7

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DETECTION BAND    5
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 2  23.14 PERCENT, OR   3 OF  13 M         VEHCLE WITH CPE OF     40. M. AND DELAY    4. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    3     7     8

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SL...                  .0.
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 DETECTION BAND   3
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  2  99.95 PERCENT, OR   4 OF   5 M TK VEH V LE12 WITH CPE OF    176. M. AND DELAY  60. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   3    5    2    1

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 DETECTION BAND    4
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  2  99.77 PERCENT, OR   8 OF   9 M TK VEH V LE12 WITH CPE OF    176. M. AND DELAY  60. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   3    4    1    3    4    2    6    3

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 DETECTION BAND   5
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  2  99.48 PERCENT, OR  10 OF  11 M TK VEH V LE12 WITH CPE OF    176. M. AND DELAY  60. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   6    3    3    6    5    9    4    5   11    1    3

  4  93.39 PERCENT, OR   1 OF   2 M WH VEH V LE12 WITH CPE OF    176. M. AND DELAY  60. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   1

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*****************************************************************************************
 SOP          NO.
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 DETECTION BAND   1
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  7  18.52 PERCENT. OR    6 OF   34 * OF TGT TYPE 2 WITH CPE OF    112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    21   21   22    9    6    4

  9  24.96 PERCENT. OR  11 OF   48 M APC     TANK   WITH CPE OF   112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    1    35    10     1    44    47    34    34     6    22    16

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 DETECTION BAND   2
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  7  14.75 PERCENT. OR    5 OF   37 * OF TGT TYPE 2 WITH CPE OF    112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    25   35   16    4   14

  9  19.96 PERCENT. OR  11 OF   59 M APC     TANK   WITH CPE OF   112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    14    5    52    59    28    43    10    29    19    53    36

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 DETECTION BAND   3
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  7  11.22 PERCENT. OR    7 OF   71 * OF TGT TYPE 2 WITH CPE OF    112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    55    *    29    45    14    39    41

  9  15.67 PERCENT. OR    2 OF   14 M APC     TANK   WITH CPE OF   112. M. AND DELAY    5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
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**************************************************************************************
LANE          415.
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DETECTION BAND   3
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 7   8.29 PERCENT. OR   1 OF   17 * OF TGT TYPE 2 WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   1

 9  12.24 PERCENT. OR   3 OF   24 # APC    TANK    WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   11    23    15

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DETECTION BAND   4
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 7   8.22 PERCENT. OR   1 OF   17 * OF TGT TYPE 2 WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   3

 9  11.28 PERCENT. OR   3 OF   24 # APC    TANK    WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   7    3    3

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DETECTION BAND   5
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 7   5.89 PERCENT. OR   8 OF 108 * OF TGT TYPE 2 WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   5   54   72   65   25   87   50   22

 9  10.42 PERCENT. OR   8 OF   75 # APC    TANK    WITH CPE OF   112. M. AND DELAY   5. MIN.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   37   45   18   64   73   75   45   27
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********************************************************************************
AOP                 445.
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 DETECTION BAND    7
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 26  25.39 PER CENT, OR     8 OF M          TANK   WITH A CPE OF    112. METERS AFTER A DELAY OF     5. MINUTES.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   10    11    10    10    25    25     6     4

 30  23.42 PER CENT, OR     1 OF M          TRUCK  WITH A CPE OF    112. METERS AFTER A DELAY OF     5. MINUTES.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
    3

 38  19.43 PER CENT, OR     3 OF M          BMP    WITH A CPE OF    112. METERS AFTER A DELAY OF     5. MINUTES.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   11     1    10

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 DETECTION BAND    9
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 26   7.01 PER CENT, OR     3 OF M          TANK   WITH A CPE OF    112. METERS AFTER A DELAY OF     5. MINUTES.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   21     8    29

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 DETECTION BAND   11
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 30   3.21 PER CENT, OR     1 OF M          TRUCK  WITH A CPE OF    112. METERS AFTER A DELAY OF     5. MINUTES.

RELATIVE NUMBERS FOR DETECTION-TARGET CORROLATION
   24
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APPENDIX D

TABULATION OF STARMAN-C OUTPUTS AND TARGET IDs

APPENDIX D

TABULATION OF STARMAN-C OUTPUT AND TARGET IDs

The tables in this appendix are a complete tabulation of all the STARMAN-C outputs used in this study. The information in all the columns except the rightmost column come directly from the model's output. The right-hand column was generated from the random number column and a knowledge of the table of equipment of each target in a given band. A unique sequential identification number was assigned to each piece of equipment of the type detected in the detection band in which the detection(s) occurred. The random number column indicated what piece of equipment and, therefore, what target was detected. For example, if two moving tanks (random numbers 4 and 26) were detected out of 28 moving tanks present in a given detection band with eight targets (31, 32, 33, 34, 51, 52, 53, 54); and targets 31, 32, 51, and 52 had seven moving tanks each; then random numbers 1 through 7 would be moving tanks in target 31, 8 through 14 would be in target 32, 15 through 21 would be in target 51, and 22 through 28 would be in target 52. In this example, targets 31 (random number 4) and 52 (random number 26) were detected. STARMAN-C is designed so that the random numbers never exceed the number of elements of the type detected in the band.

Output for Sequence 2 (continued next page)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
AOP	0245	12	3.36	1	M Tank	112	5	17	32
	0300	10	8.17	2	M Tank	112	5	28,21	32,32
		12	3.65	1	M Tank	112	5	18	52
	0315	10	6.90	1	M Tank	112	5	15	32
	0330	9	12.54	3	M Tank	112	5	14,23,16	31,32,32
	0345	9	17.69	4	M Tank	112	5	10,26,27,19	31,32,32,32
		9	10.68	1	M BMP	112	5	12	34
	0400	8	13.23	3	M Tank	112	5	7,15,28	31,32,32
		8	8.11	1	M BMP	112	5	1	33
		10	3.52	1	M Tank	112	5	18	52
		11	2.84	1	M Truck	112	5	2	2
	0415	8	25.72	8	M Tank	112	5	15,15,21,17,24,22,18, 16	32,32,32,32,32,32,32, 32
		8	22.22	1	M Truck	112	5	3	34
		8	16.61	2	M BMP	112	5	11,1	34,34
		10	7.51	3	M Tank	112	5	23,21,8	52,52,51
		12	3.39	1	M Tank	112	5	29	62
	0430	8	7.00	1	M Tank	112	5	22	32
	0445	7	25.39	8	M Tank	112	5	10,11,19,15,25,25,16, 4	31,31,32,32,32,32,32, 31
		7	23.42	1	M Truck	112	5	3	34
		7	19.43	3	M BMP	112	5	11,1,10	34,34,34

Output for Sequence 2 (concluded)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
AOP	0445	9	7.01	3	M Tank	112	5	8,5,11	51,51,51
(cont)	(cont)	11	3.21	1	M Truck	112	5	42	84
	0500	7	17.44	4	M Tank	112	5	18,23,21,25	32,32,32,32
		7	11.98	1	M BMP	112	5	12	34
		9	3.76	1	M Tank	112	5	8	51
LRRP	0215	12	3.82	1	M Tank	112	5	3	31
		13	2.05	1	S Truck	112	5	8	43
	0230	12	3.82	1	M Tank	112	5	12	31
		13	2.05	1	S Truck	112	5	6	43
	0245	12	14.76	4	M Tank	112	5	13,27,9,30	31,32,31,32
		13	7.76	5	M Truck	112	5	61,84,6,17,42	82,84,43,43,44

Output for Sequence 3 (Night) (continued next page)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
BNRDR	0015	3	23.25	1	M Vehicle	40	4	1	11
		4	23.76	2	M Vehicle	40	4	2,3	13,14
		5	23.14	3	M Vehicle	40	4	1,7,12	23,32,34
	0030	3	23.25	1	M Vehicle	40	4	1	11
		4	23.76	2	M Vehicle	40	4	4,5	14,21
		5	23.14	3	M Vehicle	40	4	2,1,10	23,23,33
	0045	3	23.25	1	M Vehicle	40	4	1	11
		4	23.76	2	M Vehicle	40	4	6,7	21,21
		5	23.14	3	M Vehicle	40	4	3,7,8	24,32,32
	0100	3	23.25	1	M Vehicle	40	4	1	11
		4	23.76	2	M Vehicle	40	4	6,8	21,22
		5	23.14	3	M Vehicle	40	4	2,1,9	23,23,33
SLAR	0015	3	99.95	4	M Tk Veh	176	60	3,5,4,4	12,12,12,12
		4	99.77	8	M Tk Veh	176	60	2,8,1,4,3,7,8,7	13,22,13,14,14,22,22, 22
		5	99.48	10	M Tk Veh	176	60	10,5,1,10,2,3,7,2,8,4	33,31,23,33,23,24,32, 23,32,24
		5	93.39	1	M Wh Veh	176	60	2	41
	0030	3	66.96	3	M Tk Veh	176	60	5,5,3	12,12,12
		4	66.85	6	M Tk Veh	176	60	4,4,6,1,8,6	14,14,21,13,22,21
		5	66.65	7	M Tk Veh	176	60	5,8,6,8,10,2,8	31,32,31,32,33,23,32
		5	66.57	1	M Wh Veh	176	60	1	34
	0045	3	99.95	4	M Tk Veh	176	60	2,5,2,1	11,12,11,11
		4	99.77	8	M Tk Veh	176	60	6,4,1,3,9,2,6,3	21,14,13,14,22,13,21, 14

Output for Sequence 3 (Night) (concluded)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
SLAR (cont)	0045 (cont)	5	99.48	10	M Tk Veh	176	60	6,3,3,6,5,9,8,6,11,1	31,24,24,31,31,33,32, 31,34,23
		5	93.39	1	M Wh Veh	176	60	1	34
	0100	3	51.97	2	M Tk Veh	176	60	1,1	11,11
		4	51,88	4	M Tk Veh	176	60	1,2,4,7	13,13,14,22
		5	51.73	5	M Tk Veh	176	60	9,11,5,10,1	33,34,31,33,23
LRRP	0015	3	16.75	1	M Vehicle	112	5	5	12
	0030	3	16.75	1	M Vehicle	112	5	4	12
	0045	3	16.75	1	M Vehicle	112	5	2	11
	0100	3	16.75	1	M Vehicle	112	5	6	12

Output for Sequence 3 (Day) (continued next page)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
BNRDR	0400	4	10.68	4	M Vehicle	40	4	1,9,40,26	91,91,94,93
		5	10.40	4	M Vehicle	40	4	11,30,6,27	101,103,101,103
		6	9.67	5	M Vehicle	40	4	7,38,34,38,13	141,144,144,144,142
		7	8.21	13	M Vehicle	40	4	134,128,60,31,134,133, 22,25,154,51,147,137, 71	153,153,121,113,153, 153,112,113,154,121, 154,153,131
		8	6.81	3	M Vehicle	40	4	31,27,12	163,163,162
		9	5.10	9	M Vehicle	40	4	39,90,41,15,140,71,158, 4,4	54,64,54,52,183,62, 184,51,51
		10	3.09	1	M Vehicle	40	4	37	84
		11	1.22	1	M Vehicle	40	4	60	34
	0415	6	2.01	5	M Vehicle	40	4	4,81,32,141,157	111,132,113,154,154
		8	1.75	1	M Vehicle	40	4	36	164
		9	1.33	2	M Vehicle	40	4	82,96	63,64
	0430	5	1.85	1	M Vehicle	40	4	1	141
		6	1.81	3	M Vehicle	40	4	91,58,120	133,121,152
		7	1.75	1	M Vehicle	40	4	15	162
		8	1.57	2	M Vehicle	40	4	45,104	54,183
		10	0.68	1	M Vehicle	40	4	78	82
	0500	2	18.15	7	M Vehicle	40	4	1,32,29,32,14,16,7	91,93,93,93,92,92,91
		3	14.98	6	M Vehicle	40	4	34,8,41,6,21,4	101,104,104,101,102, 101
		4	12.91	6	M Vehicle	40	4	39,13,11,12,39,15	144,142,141,142,144, 142
		5	10.93	18	M Vehicle	40	4	146,111,74,143,65,93, 128,36,138,45,47,106, 48,97,127,84,148,5	154,151,132,154,131, 133,152,113,153,114, 114,134,114,134,152, 132,154,111

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
BNRDR (cont)	0500 (cont)	6	8.45	4	M Vehicle	40	4	28,38,36,43	163,164,164,164
		7	5.16	3	M Vehicle	40	4	64,27,37	171,53,54
		8	2.10	2	M Vehicle	40	4	20,73	62,182
	0515	2	16.30	14	M Vehicle	40	4	3,80,75,70,70,20,47, 66,78,55,30,25,10,22,	91,104,103,103,103,92, 101,103,104,102,93,93, 91,92
		4	11.59	24	M Vehicle	40	4	119,196,21,114,25,70, 161,61,8,140,29,198, 181,47,204,11,153,85, 81,20,31,151,182,83	152,144,112,151,113, 131,141,131,111,153, 113,144,143,114,144, 111,154,133,132,112, 113,154,143,132
		6	7.59	4	M Vehicle	40	4	38,26,27,39	164,163,163,164
		7	4.63	5	M Vehicle	40	4	105,88,10,113,9	64,64,51,181,51
		8	1.88	1	M Vehicle	40	4	13	82
	0530	2	16.27	14	M Vehicle	40	4	3,11,9,77,28,7,81,63, 58,28,48,8,11,59	91,91,91,104,93,91, 104,102,102,93,101,91, 91,102
		3	13.57	14	M Vehicle	40	4	88,67,94,30,92,75,85, 12,18,94,69,12,52,57	154,153,154,142,154, 153,154,142,142,154, 152,142,144,151
		4	11.84	12	M Vehicle	40	4	76,13,88,88,57,19,42, 83,58,79,31,49	132,133,133,121,112, 114,132,121,132,113, 121,112
		5	10.19	5	M Vehicle	40	4	2,14,15,46,51	161,162,162,164,164
		6	7.75	5	M Vehicle	40	4	4,28,17,24,28	51,53,52,53,53
		7	4.87	4	M Vehicle	40	4	81,7,25,71	183,61,63,181
		8	2.07	2	M Vehicle	40	4	86,27	82,43

Output for Sequence 3 (Day((continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
BNRDR (cont)	0545	1	17.25	7	M Vehicle	40	4	2,13,13,42,36,40,16	91,92,92,94,94,94,92
		2	14.16	13	M Vehicle	40	4	67,41,1,72,83,15,14, 20,38,75,4,70,16	153,104,101,153,154, 102,102,102,104,153, 101,153,102
		3	11.81	17	M Vehicle	40	4	136,136,46,33,37,39,25 135,59,82,127,91,137, 98,55,48,84	143,143,114,113,114, 114,113,143,121,132, 142,133,143,134,121, 114,132
		4	10.31	5	M Vehicle	40	4	9,18,45,34,49	161,162,164,164,164
		6	6.75	10	M Vehicle	40	4	111,1,128,35,117,49, 28,119,147,100	181,183,54,181,54,53, 182,184,64,181
		7	4.24	3	M Vehicle	40	4	25,14,37	83,82,84
		8	1.80	1	M Vehicle	40	4	18	42
	0600	1	15.78	14	M Vehicle	40	4	3,27,35,77,32,5,16,81, 18,14,48,16,76,65	91,93,94,104,93,91,92, 104,92,92,101,92,104, 103
		2	12.96	12	M Vehicle	40	4	70,7,29,76,75,70,24, 95,48,87,30,11	153,141,143,154,153, 153,143,154,151,154, 143,142
		3	10.81	11	M Vehicle	40	4	95,27,37,38,87,40,15, 82,69,100,4	133,113,114,114,133, 114,112,132,131,134, 111
		4	9.43	5	M Vehicle	40	4	2,46,43,30,18	161,164,164,163,162
		5	8.12	5	M Vehicle	40	4	45,17,3,33,45	54,52,51,53,54
		6	6.17	4	M Vehicle	40	4	71,17,5,35	181,62,61,64
		7	3.88	5	M Vehicle	40	4	13,122,72,26,99	42,81,81,43,83
LRRP	0400	4	19.05	3	M Trk/BRDM	112	5	1,10,2	91,94,91
		4	24.77	5	M Tank	112	5	20,9,24,19,7	93,92,93,93,91

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
LRRP (cont)	0400 (cont)	5	18.47	3	M Trk/BRDM	112	5	3,7,11	101,103,104
		5	24.22	5	M Tank	112	5	18,7,1,20,5	103,101,101,103,101
		6	17.54	3	M Trk/BRDM	112	5	2,6,5	141,142,142
		6	23.36	6	M Tank	112	5	14,4,9,14,6,24	142,141,142,142,141, 143
		7	15.90	15	M Trk/BRDM	112	5	57,36,15,34,17,85,46, 42,79,79,12,82,32,51, 56	133,131,114,131,114, 154,132,132,153,153, 114,154,131,133,133
		7	21.64	10	M Tank	112	5	23,38,31,44,35,32,44, 11,28,21	151,153,152,153,152, 152,153,113,152,151
		8	13.01	2	M Trk/BRDM	112	5	17,8	164,164
		8	18.46	2	M Tank	112	5	4,6	161,162
		9	7.83	7	M Trk/BRDM	112	5	91,29,63,8,34,72,77	184,64,182,54,64,183, 183
		9	11.80	3	M Tank	112	5	23,24,2	62,62,51
	0415	3	8.29	1	M Trk/BRDM	112	5	16	94
		3	12.24	3	M Tank	112	5	11,23,15	92,93,92
		4	9.02	1	M Trk/BRDM	112	5	5	102
		4	11.88	3	M Tank	112	5	7,3,3	101,101,101
		6	6.89	8	M Trk/BRDM	112	5	6,64,72,60,26,87,50,22	113,134,151,134,121, 154,133,121
		6	10.42	8	M Tank	112	5	32,45,18,64,70,75,46, 27	152,153,151,142,143, 143,153,152
	0430	3	7.57	1	M Trk/BRDM	112	5	11	94
		3	11.18	2	M Tank	112	5	4,4	91,81
		4	7.32	1	M Trk/BRDM	112	5	7	103
		4	10.85	2	M Tank	112	5	8,18	101,103
		5	6.19	1	M Trk/BRDM	112	5	8	143

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
LRRP (cont)	0430 (cont)	5	10.31	3	M Tank	112	5	25,27,10	143,143,141
		6	6.29	6	M Trk/BRDM	112	5	44,88,29,57,54,43	132,154,131,133,133, 132
		6	9.52	5	M Tank	112	5	46,35,41,10,30	153,152,153,112,152
		7	7.98	1	M Tank	112	5	13	163
		8	3.13	2	M Trk/BRDM	112	5	51,34	182,181
BNOP	0500	2	13.57	2	M Trk/BRDM	112	5	16,7	94,93
		2	18.72	4	M Tank	112	5	2,13,5,23	91,92,91,93
		3	10.29	1	M Trk/BRDM	112	5	14	104
		3	14.67	3	M Tank	112	5	16,2,2	182,101,101
		4	5.70	1	M Trk/BRDM	112	5	15	144
		4	8.58	2	M Tank	112	5	15,1	142,141
	0515	2	13.61	4	M Trk/BRDM	112	5	10,8,1,16	94,93,91,94
		2	18.77	9	M Tank	112	5	17,4,13,32,19,13,6,20, 23	93,91,92,101,93,92, 91,93,93
		4	5.69	6	M Trk/BRDM	112	5	97,1,83,34,33,79	143,111,154,131,131, 153
		4	8.57	6	M Tank	112	5	39,44,62,72,61,58	153,153,142,143,142, 142
	0530	2	14.89	5	M Trk/BRDM	112	5	33,2,7,10,16	104,104,93,94,94
		2	20.15	9	M Tank	112	5	34,40,6,14,30,34,34,12, 11	102,102,91,92,101,102, 102,92,92
		3	11.26	4	M Trk/BRDM	112	5	5,22,4,17	142,152,142,144
		3	15.73	9	M Tank	112	5	21,14,41,17,5,18,24, 53,21	143,142,152,142,141, 142,143,153,143
		4	6.33	4	M Trk/BRDM	112	5	53,33,12,7	133,131,114,114
		4	9.39	1	M Tank	112	5	13	113

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
BNOP (cont)	0545	1	8.97	3	M Trk/BRDM	112	5	9,14,5	93,94,92
		1	25.16	6	M Tank	112	5	12,3,13,16,11,7	92,91,92,93,92,91
		2	15.03	5	M Trk/BRDM	112	5	33,25,33,33,22	154,153,154,154,152
		2	20.34	10	M Tank	112	5	15,18,24,34,3,46,23,22, 6,41	102,103,103,151,101, 153,103,103,101,151
		3	11.23	8	M Trk/BRDM	112	5	45,65,13,24,4,68,72,62	132,134,114,121,112, 134,141,134
		3	15.69	7	M Tank	112	5	3,37,33,38,24,21,12	111,143,142,143,141, 141,113
		4	6.35	1	M Trk/BRDM	112	5	15	164
		4	9.42	1	M Tank	112	5	6	162
	0600	1	18.82	6	M Trk/BRDM	112	5	21,21,22,9,6,4	102,102,102,93,92,92
		1	24.96	11	M Tank	112	5	1,35,10,1,44,47,34,34, 8,22,16	91,102,92,91,103,103, 102,102,91,93,92
		2	14.75	5	M Trk/BRDM	112	5	25,35,16,4,18	153,154,144,142,151
		2	19.96	11	M Tank	112	5	13,5,52,59,28,43,10,29, 19,53,36	142,141,153,153,143, 152,141,143,142,153, 151
		3	11.22	7	M Trk/BRDM	112	5	55,8,29,46,18,39,41	133,114,131,132,121, 132,132
		3	15.67	2	M Tank	112	5	3,3	111,111
		4	6.34	1	M Trk/BRDM	112	5	6	163
		4	9.40	1	M Tank	112	5	6	162
AOP	0400	4	7.31	2	M Tank	112	5	22,6	93,91
		5	6.13	2	M Tank	112	5	13,5	102,101
		6	4.82	2	M Tank	112	5	12,13	142,142
		7	2.83	2	M Tank	112	5	30,42	152,153
		7	4.30	3	M Truck	112	5	46,41,27	132,132,121

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
AOP (cont)	0400 (cont)	9	3.65	2	M Tank	112	5	10,1	52.51
		9	3.04	3	M Truck	112	5	32,20,45	64,62,171
	0415	3	9.05	3	M Tank	112	5	21,4,1	93,91,91
		4	6.89	2	M Tank	112	5	18,21	103,103
		6	4.51	4	M Tank	112	5	68,33,20,49	143,142,151,141
		6	3.75	3	M Truck	112	5	15,38,68	114,131,134
		9	3.41	2	M Tank	112	5	8,5	52,51
		9	2.83	2	M Truck	112	5	8,22	54,63
	0430	3	9.05	3	M Tank	112	5	16,11,16	92,92,92
		4	6.89	2	M Tank	112	5	14,18	102,103
		5	5.75	2	M Tank	112	5	23,9	143,141
		6	4.51	3	M Tank	112	5	46,13,41	153,113,153
		6	3.75	3	M Truck	112	5	62,9,7	134,114,114
		8	3.50	2	M Truck	112	5	18,27	171,171
		10	1.64	1	M Truck	112	5	26	71
	0445	2	9.28	3	M Tank	112	5	1,19,14	91,93,92
		3	6.73	2	M Tank	112	5	20,19	103,103
		5	4.28	4	M Tank	112	5	20,25,43,31	151,151,153,152
		5	3.57	3	M Truck	112	5	56,24,14	133,121,114
		5	3.51	1	M BRDM	112	5	9	153
		8	2.60	2	M Truck	112	5	12,47	54,181
		9	2.11	1	M Truck	112	5	24	82
	0500	2	7.98	2	M Tank	112	5	10,16	92,92
		2	6.70	1	M BRDM	112	5	2	91
		3	5.85	2	M Tank	112	5	5,11	101,102
		4	4.48	2	M Tank	112	5	10,1	141,141
		5	3.76	2	M Tank	112	5	35,15	152,113

Output for Sequence 3 (Day) (continued)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
AOP (cont)	0500 (cont)	5	3.14	2	M Truck	112	5	57,27	133,121
		7	2.63	1	M Truck	112	5	23	54
		8	2.30	2	M Truck	112	5	3,20	61,181
		9	1.86	2	M Truck	112	5	4,57	71,44
	0515	2	7.39	4	M Tank	112	5	12,32,31,47	92,101,101,103
		2	6.16	2	M BRDM	112	5	4,1	92,91
		4	4.08	4	M Tank	112	5	64,18,71,41	142,151,143,153
		4	3.41	3	M Truck	112	5	12,61,31	114,134,131
		7	2.38	2	M Truck	112	5	15,43	54,181
		8	2.07	1	M Truck	112	5	17	81
	0530	2	6.38	4	M Tank	112	5	29,42,3,11	101,103,91,92
		2	5.43	1	M Truck	112	5	4	94
		2	5.34	2	M BRDM	112	5	4,6	92,92
		3	4.66	3	M Tank	112	5	17,31,46	142,151,152
		3	3.86	1	M BRDM	112	5	1	141
		4	2.98	2	M Truck	112	5	53.49	133,133
		7	2.08	1	M Truck	112	5	26	181
		8	1.82	2	M Truck	112	5	18,50	71,83
	0545	1	8.44	3	M Tank	112	5	23,21,23	93,93,93
		1	7.27	1	M BRDM	112	5	5	92
		2	5.23	3	M Tank	112	5	23,42,53	103,152,153
		2	4.39	2	M BRDM	112	5	1,18	101,151
		3	3.83	2	M Tank	112	5	32,34	142,142
		3	3.23	3	M Truck	112	5	38,28,53	131,121,133
		6	1.61	1	M Truck	112	5	38	181
		7	1.72	1	M Truck	112	5	28	83

Output for Sequence 3 (Day) (concluded)

Sensor type	Time	Band	Percent	Nr	Type	CPE (m)	Delay (min)	Random numbers	Target ID
AOP (cont)	0600	1	7.65	4	M Tank	112	5	5,29,49,11	91,101,102,92
		1	6.63	1	M Truck	112	5	1	94
		1	6.53	2	M BRDM	112	5	16,12	94,94
		2	4.64	3	M Tank	112	5	43,1,44	152,141,152
		2	3.87	1	M BRDM	112	5	24	153
		3	3.37	1	M Tank	112	5	4	111
		3	2.83	2	M Truck	112	5	41,17	132,114
		6	1.40	1	M Truck	112	5	42	183
		7	1.49	1	M Truck	112	5	16	44

APPENDIX E

FIRST DETECTION TABLES

APPENDIX E

FIRST DETECTION TABLES

1. The tables in this appendix give the time and band at which each target in the scenario was first detected. All of the company/platoon-sized targets are listed in the leftmost column. If a target was not detected, its time and band were left blank. The second and third columns list the time and band at which each target was first detected by any sensor. The remaining four pairs of columns contain the time and band at which each target was first detected by the specific sensor system named at the top of these columns. Again, if a target was not detected by the specific sensor system the time and band information was left blank.

2. The information contained in the three tables in this appendix was used to calculate the average time to first detection and the average range from SL at first detection MOEs in tables VIII and IX for all the sensors together and for each sensor individually. The average times to first detection were calculated by averaging the time delay in minutes from the start time of the scenario to the time of first detection for all detected targets. The start times were 0200 for sequence 2, 0015 for sequence 3 (night), and 0400 for sequence 3 (day). The average ranges from the SL at first detection were evaluated by calculating the average band at first detection given in the appropriate column of these tables and multiplying by the bandwidth for that scenario.

First Detection Table - Sequence 2 (continued next page)

Tgt ID	Overall		AOP		LRRP					
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
2	0400	11	0400	11						
31	0215	12	0330	9	0215	12				
32	0245	12	0245	12	0245	12				
33	0400	8	0400	8						
34	0345	9	0345	9						
51	0415	10	0415	10						
52	0300	12	0300	12						
53										
54										
61										
62	0415	12	0415	12						
63										
64										
81										
82	0245	13			0245	13				
83										

First Detection Table - Sequence 2 (concluded)

Tgt ID	Overall		AOP		LRRP					
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
84	0245	13	0445	11	0245	13				
41										
42										
43	0215	13			0215	13				
44	0245	13			0245	13				

First Detection Table - Sequence 3 (Night)

Tgt ID	Overall		SLAR		LRRP		BNRDR			
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
11	0015	3	0045	3	0045	3	0015	3		
12	0015	3	0015	3	0015	3				
13	0015	4	0015	4			0015	4		
14	0015	4	0015	4			0015	4		
21	0030	4	0030	4			0030	4		
22	0015	4	0015	4			0100	4		
23	0015	5	0015	5			0015	5		
24	0015	5	0015	5			0045	3		
31	0015	5	0015	5						
32	0015	5	0015	5			0015	5		
33	0015	5	0015	5			0030	5		
34	0030	5	0030	5			0015	5		
41	0015	5	0015	5						

First Detection Table - Sequence 3 (Day) (continued next page)

Tgt ID	Overall		AOP		GOP		LRRP		BNRDR	
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
11										
21										
22										
23										
24										
31										
32										
33										
34	0400	11							0400	11
41										
42	0545	8							0545	8
43	0530	8							0530	8
44	0500	9	0500	9						
51	0400	9	0400	9			0400	9	0400	9
52	0400	9	0400	9					0400	9
53	0500	7							0500	7

First Detection Table - Sequence 3 (Day) (continued next page)

Tgt ID	Overall		AOP		GOP		LRRP		BNRDR	
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
54	0400	9	0415	9			0400	9	0400	9
61	0500	8	0500	8					0530	7
62	0400	9	0400	9			0400	9	0400	9
63	0415	9	0415	9					0415	9
64	0400	9	0400	9			0400	9	0400	9
71	0430	10	0430	10						
81	0430	3	0515	8					0600	7
82	0415	9	0445	9					0430	10
83	0530	8	0530	8					0545	7
84	0400	10							0400	10
91	0400	4	0400	4	0500	2	0400	4	0400	4
92	0400	4	0430	3	0500	2	0400	4	0500	2
93	0400	4	0400	4	0500	2	0400	4	0400	4
94	0400	4	0530	2	0500	2	0400	4	0400	4
101	0400	5	0400	5	0500	3	0400	5	0400	5
102	0400	5	0400	5	0500	3	0415	4	0500	3

First Detection Table - Sequence 3 (Day) (continued next page)

Tgt ID	Overall		AOP		GOP		LRRP		BNRDR	
	Time	Band	Time	Band	Time	Band	Time	Band	Time	Band
103	0400	5	0415	4	0545	2	0400	5	0400	5
104	0400	5			0500	3	0400	5	0500	3
111	0415	6	0600	3	0515	4			0415	6
112	0400	7			0545	3	0415	6	0400	7
113	0400	7	0430	6	0530	4	0415	6	0400	7
114	0400	7	0415	6	0530	4	0400	7	0500	5
121	0400	7	0400	7	0545	3	0415	6	0400	7
131	0400	7	0415	6	0515	4	0400	7	0400	7
132	0400	7	0400	7	0545	3	0400	7	0415	6
133	0400	7	0445	5	0530	4	0400	7	0430	6
134	0415	6	0415	6	0545	3	0415	6	0600	3
141	0400	6	0415	6	0500	4	0400	6	0400	6
142	0400	6	0400	6	0500	4	0400	6	0400	6
143	0400	6	0415	6	0515	4	0400	6	0500	5
144	0400	6			0500	4			0400	6
151	0400	7	0415	6	0545	2	0400	7	0500	5

APPENDIX F

PERCENT OF TARGETS DETECTED VERSUS RANGE AND PERCENT OF TARGET ELEMENTS DETECTED (BY TYPE) VERSUS RANGE

APPENDIX F

PERCENT OF TARGETS DETECTED VERSUS RANGE AND
PERCENT OF TARGET ELEMENTS DETECTED (BY TYPE) VERSUS RANGE

1. The following tables were developed from the STARMAN-C outputs contained in appendix D.

2. Two kinds of tables are contained in this appendix.

a. The first is percent of targets detected during each sequence. The entries in these tables are the number of targets detected per number of targets presented in each detection band at the time of each snapshot evaluated. No entry indicates that there were no targets present in that detection band at the corresponding time. The number of targets detected and number of targets presented are totaled by detection band. These fractions are also presented in percentage form. These values represent the average percentage of targets detected in a given range band for each snapshot when there are targets present. The table entries were also used in conjunction with the corresponding tables in appendix D to determine the number of different company/platoon targets detected per number of different targets exposed in each detection band during the entire evaluation period. These ratios are listed at the bottom of the first three tables and represent the percentage of targets detected in each detection band during the total duration of the evaluation.

b. The second group of tables are similar to the first except they are for percent of target elements (instead of targets) detected during each sequence. The entries in these tables are totaled only into

percentages, which indicate the average number of target elements detected in a given range band for each snapshot.

3. The BASIC computer program following these tables was developed to take the information developed in the tables and plot the histograms contained in main report figures 3 through 13 on the desk top HP 9830A computer system. These figures were generated to address EEA 5 and identify any voids existing in the detection capabilities of the forces evaluated.

Percent of Targets Detected - Sequence 2

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0200												0/4	0/8	0/8	0/5		0/8	0/1	0/4	
0215												1/4	1/8	0/8	0/5		0/8	0/1	0/4	
0230												1/4	1/8	0/8	0/5		0/8	0/1	0/4	
0245												2/4	4/8	0/9	0/4		0/8	0/1	0/4	
0300										1/4		1/8	0/5	0/5	0/4	0/4	0/5	0/5	0/5	
0315										1/4	0/4	0/5	0/4	0/8		0/4	0/9		0/4	0/1
0330									2/4		0/8	0/1	0/8	0/4	0/4	0/4	0/5		0/4	0/1
0345									3/4		0/8	0/5	0/4	0/4	0/4	0/9		0/4	0/1	0/4
0400								3/4		1/4	1/5	0/4	0/8		0/8	0/5		0/4	0/1	0/4
0415								2/4		2/4	1/5	0/8	0/4		0/8	0/5		0/4	0/1	0/4
0430								1/4		0/5	0/8	0/4	0/4		0/12	0/1	0/4	0/1	0/4	
0445							3/4		1/4	0/1	1/8	0/8		0/8	0/5		0/4	0/1	0/4	
0500							2/4		1/4	0/1	0/8	0/8		0/8	0/5		0/5		0/4	0/4
[a]Total							5/8	6/12	7/16	5/23	3/54	5/67	6/69	0/70	0/69	0/32	0/64	0/23	0/44	0/18
Percent							62	50	44	22	6	7	9	0	0	0	0	0	0	0
(Note b)							3/4	4/4	4/8	3/9	2/17	4/25	4/17	0/21	0/18	0/13	0/18	0/10	0/13	0/9
Percent							75	100	50	33	12	16	24	0	0	0	0	0	0	0

Notes: a. Number targets detected/number targets presented. b. Number different company targets detected/number different company targets presented.

Percent of Targets Detected - Sequence 3 (night)

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0015			2/2	3/4	6/7															
0030			2/2	4/4	5/7															
0045			2/2	4/4	7/7															
0100			2/2	4/4	4/7															
[a]Total			8/8	15/16	22/28															
Percent			100	94	79															
(Note b)			2/2	4/4	7/7															
Percent			100	100	100															

Notes: a. Number targets detected/number targets presented. b. Number different platoon targets detected/number different platoon targets presented.

Percent of Targets Detected - Sequence 3 (day)

Time	Detection Band																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0400				4/4	4/4	4/4	11/13	4/4	9/13	1/4	1/9	0/1		0/4						
0415			4/4	3/4		15/17		2/5	5/12	0/5	0/8	0/1	0/4							
0430			3/4	3/4	2/4	12/13	2/4	5/9	0/4	2/9	0/5		0/4							
0445		1/4	3/4		6/17		0/5	2/12	1/5	0/4	0/5		0/4							
0500		4/4	3/4	3/4	12/13	2/4	3/5	4/8	2/9	0/1	0/4	0/4								
0515		8/8		16/17		2/5	4/12	2/5	0/4	0/1	0/4	0/4								
0530		8/8	8/8	8/9	3/4	3/5	2/8	4/9		0/1	0/8									
0545	4/4	8/8	12/13	4/4	0/1	7/12	3/5	1/4	0/1	0/4	0/4									
0600	8/8	8/8	9/9	4/4	4/5	5/8	5/9		0/1	0/8										
aTotal	12/12	37/40	42/46	45/50	31/48	50/68	30/61	24/56	17/49	3/37	1/47	0/10	0/12	0/4						
Percent	100	93	91	90	65	74	49	44	35	8	2	0	0	0						
(Note b)	8/8	16/16	25/25	28/29	25/30	30/34	28/39	17/26	15/23	3/18	1/14	0/5	0/4	0/4						
Percent	100	100	100	97	83	88	72	65	65	17	7	0	0	0						

Notes: a. Number targets detected/number targets presented. b. Number different company targets detected/number different company targets presented.

Percent of Tank Elements Detected - Sequence 2

Time	Detection Band																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0200												0/32		0/64					0/32	
0215												1/32		0/64					0/32	
0230												1/32		0/64					0/32	
0245												5/32		0/64					0/32	
0300										2/32		1/32		0/32				0/32	0/32	
0315										1/28		0/32		0/32				0/32	0/32	
0330									3/28		0/32		0/32				0/32		0/32	
0345									4/28		0/32		0/32			0/32		0/32		0/32
0400								3/28		1/32			0/32			0/32		0/32		0/32
0415								8/28		3/32		1/32				0/32		0/32		0/32
0430								1/28		0/32		0/32			0/32		0/32		0/32	
0445							8/28		3/32			0/32			0/32		0/32		0/32	
0500							4/28		1/32			0/32			0/32		0/32		0/32	0/16
Total*							12/56	12/84	11/120	7/156	0/64	9/320	0/96	0/320	0/96	0/96	0/128	0/160	0/320	0/112
Percent							21	14	9	4	0	3	0	0	0	0	0	0	0	0

* Number tank elements detected/number tank elements presented.

Percent of Truck Elements Detected - Sequence 2

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0200												0/6	0/86	0/12	0/43		0/71	0/28	0/6	
0215												0/6	1/86	0/12	0/43		0/71	0/28	0/6	
0230												0/6	1/86	0/12	0/43		0/71	0/28	0/6	
0245												0/6	5/86	0/12	0/43		0/71	0/28	0/6	
0300										0/6		0/49	0/54	0/6	0/32	0/43	0/56	0/6	0/6	
0315										0/6	0/43	0/17	0/43	0/38		0/43	0/62		0/6	0/11
0330									0/6		0/49	0/11	0/49	0/32	0/43	0/28	0/34		0/6	0/11
0345									0/6		0/49	0/54	0/6	0/32	0/43	0/62		0/6	0/11	0/6
0400								0/6		0/6	1/54	0/43	0/38		0/71	0/34		0/6	0/11	0/6
0415								1/6		0/6	0/54	0/49	0/32		0/71	0/34		0/6	0/11	0/6
0430								0/6		0/17	0/86	0/6	0/32		0/77	0/28	0/6	0/11	0/6	
0445							1/6		0/6	0/11	1/86	0/38		0/71	0/34		0/6	0/11	0/6	
0500							0/6		0/6	0/11	0/86	0/38		0/71	0/34		0/17		0/6	0/17
Total*							1/12	1/18	0/24	0/63	2/507	0/329	7/598	0/298	0/577	0/272	0/465	0/158	0/93	0/57
Percent							8	6	0	0	0	0	1	0	0	0	0	0	0	0

* Number truck elements detected/number truck elements presented.

Percent of BMP Elements Detected - Sequence 2

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0200												0/13	0/2	0/26	0/5		0/30		0/13	
0215												0/13	0/2	0/26	0/5		0/30		0/13	
0230												0/13	0/2	0/26	0/5		0/30		0/13	
0245												0/13	0/2	0/26	0/5		0/30		0/13	
0300										0/13		0/14	0/1	0/13	0/5	0/1	0/29	0/13	0/13	
0315										0/13	0/1	0/13	0/1	0/18		0/1	0/42		0/13	
0330									0/13		0/14		0/14	0/5	0/1	0/29	0/13		0/13	
0345									1/13		0/14	0/1	0/13	0/5	0/1	0/42		0/13		0/13
0400								1/13		0/13	0/1	0/1	0/18		0/30	0/13		0/13		0/13
0415								2/13		0/13	0/1	0/14	0/5		0/30	0/13		0/13		0/13
0430								0/13		0/13	0/2	0/13	0/5		0/43		0/13		0/13	
0445							3/13		0/13		0/2	0/18		0/30	0/13		0/13		0/13	
0500							1/13		0/13		0/2	0/18		0/30	0/13		0/13		0/13	0/20
Total*							4/26	3/39	1/52	0/65	0/37	0/144	0/65	0/205	0/156	0/99	0/243	0/52	0/130	0/59
Percent							15	8	2	0	0	0	0	0	0	0	0	0	0	0

* Number BMP elements detected/number BMP elements presented.

Percent of BRDM Elements Detected - Sequence 3 (night)

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0015			4/5	6/9	9/11															
0030			4/5	5/9	6/11															
0045			3/5	7/9	8/11															
0100			2/5	6/9	6/11															
Total*			13/20	24/36	29/44															
Percent			65	67	66															

* Number BRDM elements detected/number BRDM elements presented.

Percent of BMP Elements Detected - Sequence 3 (night)

	Detection Band																			
Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0015			0/1	0/1	1/2															
0030			0/1	0/1	1/2															
0045			0/1	0/1	1/2															
0100			0/1	0/1	0/2															
Total*			0/4	0/4	3/8															
Percent			0	0	38															

* Number BMP elements detected/number BMP elements presented.

Percent of Tank Elements Detected - Sequence 3 (day)

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0400				7/24	7/24	8/29	12/46	2/16	5/32											
0415			6/24	5/24		12/25		0/16	2/32											
0430			5/24	4/24	5/29	8/46	1/16	0/16	0/16											
0445		3/24	2/24		4/75		0/16	0/32												
0500		6/24	5/24	4/29	2/46	0/16	0/16	0/16												
0515		22/48		10/75		0/16	0/32													
0530		13/48	12/59	1/16		0/16	0/16													
0545	9/24	13/54	9/45	1/16		0/32														
0600	15/48	14/59	3/16	1/16	0/16															
Total*	24/72	71/257	42/216	33/224	18/190	28/180	13/142	2/96	7/80											
Percent	33	28	19	15	9	16	9	2	9											

* Number tank elements detected/number tank elements presented.

Percent of Truck Elements Detected - Sequence 3 (day)

Time	Detection Band																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0400				2/6	2/6	2/6	23/77	0/17	0/88	0/32	0/71	0/28		0/43						
0415			2/6	2/6		1/83		0/28	0/77	0/43	0/60	0/28	0/43							
0430			2/6	2/6	2/6	24/77	0/17	0/71	0/17	0/60	0/71		0/43							
0445		2/6	2/6		3/83		0/28	2/62	1/43	0/17	0/71		0/43							
0500		2/6	2/6	2/6	27/77	0/17	1/28	2/45	2/60	0/28	0/43	0/43								
0515		5/12		3/83		1/28	2/56	1/43	0/17	0/28	0/43	0/43								
0530		3/12	2/12	2/71	1/17	0/28	1/45	2/60		0/28	0/86									
0545	2/6	2/6	3/77	7/17	1/17	1/77	1/43	0/17	0/28	0/43	0/43									
0600	3/12	2/12	2/71	7/17	2/28	1/60	1/60		0/28	0/86										
Total*	5/18	16/54	15/184	27/212	38/234	30/376	29/354	7/343	3/358	0/365	0/488	0/142	0/129	0/43						
Percent	28	30	8	13	16	8	8	2	1	0	0	0	0	0						

* Number truck elements detected/number truck elements presented.

Percent of BRDM Elements Detected - Sequence 3 (day)

Time	Detection Band 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0400				1/11	1/11	1/12	1/13		1/6		0/3									
0415			1/11	1/11		1/23			1/6		0/3									
0430			1/11	1/11	1/12	1/13		0/3	0/3	1/3										
0445		1/11	1/11		2/25			1/6		0/3										
0500		2/11	1/11	1/12	1/13		0/3	0/3	0/3											
0515		2/22	1/12	1/13			1/6		0/3											
0530		2/22	1/25			0/3	1/3		0/3											
0545	1/11	2/24	1/12			1/6			0/3											
0600	2/22	1/25			0/3	1/3		0/3												
Total*	3/33	10/115	7/93	5/58	5/64	5/60	3/25	1/15	2/27	1/6	0/6									
Percent	9	9	7	9	8	8	12	7	7	17	0									

*Number BRDM elements detected/number BRDM elements presented.

```
10 DISP "DETECTION BAND WIDTH ?";
20 INPUT H
30 DISP "NUMBER OF BANDS ?";
40 INPUT L
42 R=L*H
44 DISP "MAX DETECTION RATE ?";
46 INPUT D
50 SCALE -R/5,1.1*R,-D/5,1.02*D
60 XAXIS 0,H,0,R+H
70 YAXIS 0,D/10,0,D
80 LABEL (*,1.7,1.7,0,7/10)
90 FOR I=H TO R STEP H
95 PLOT I,0,1
100 IF I>9 THEN 115
105 CPLOT -0.5,-2
110 GOTO 120
115 CPLOT -0.25,-2
120 LABEL (140)I
130 NEXT I
131 PLOT 0.85*R,-0.15*D,1
133 LABEL (*)"KILOMETERS"
140 FORMAT F3.0
145 LABEL (*,2,1.7,0,7/10)
150 FOR I=D/10 TO D STEP D/10
160 PLOT 0,I,1
170 CPLOT -6.5,-0.3
180 LABEL (200)I
190 NEXT I
200 FORMAT F6.2
201 PLOT -0.125*R,0.75*D,1
202 LABEL (*,2,1.7,PI/2,7/10)"FREQUENCY"
203 PLOT 0.4*R,0.95*D,1
204 LABEL (*,3,1.7,0,7/10)"SEQUENCE 3 DAY
205 PLOT 0.35*R,0.9*D
206 LABEL (*)"TARGETS DETECTED BY STANO"
208 X=0
209 PLOT H,0,1
210 DISP "DETECTS,OPPORTUNITIES?";
215 INPUT N,D
220 X=H+X
230 PLOT X,N/D,2
240 PLOT X+H,N/D,2
250 PLOT X+H,0,2
260 GOTO 210
270 STOP
280 END
```

APPENDIX G

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DISTRIBUTION LIST

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